ADB

Technical Assistance Consultant's Report

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Islamic Republic of Pakistan: Balochistan Water Resources Development Project
(Financed by the Japan Fund for Poverty Reduction)

Feasibility Report – Siri Toi Dam

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For: Irrigation Department, Government of Balochistan, Pakistan

Asian Development Bank

The Government of Balochistan

Balochistan Water Resources Development
Project Preparatory Technical Assistance
(TA 8800-PAK)

FEASIBILITY REPORT – SIRI TOI DAM

November, 2017

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Japan Fund for Poverty Reduction

From the People of Japan

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Acronyms

ADB	Asian Development Bank
BWRDP	Balochistan Water Resources Development Project
BID	Balochistan Irrigation Department
CFSR	Climate Forecast System Reanalysis
CN	Curve Number
DEM	Digital Elevation Model
EA	Executing Agency
ET	Evapotranspiration
FAO	Food and Agriculture Organization
FDRM	Flood and Drought Risk Management
GOB	Government of Balochistan Irrigation Department
GIS	Geographical Information System
GLC	Global Land Cover
HRUs	Hydrologic Response Units
HWSD	Harmonized World Soil Data
IRBM	Integrated River Basin Management
IWRM	Integrated Water Resources Management
MCM	Million Cubic Meter
PPTA	Project Preparatory Technical Assistance
SCS	Soil Conservation Services
SOLAWC	Soil Available Water Capacity
SRTM	Shuttle Radar Topography Mission
SWAT	Soil and Water Assessment Tool
TA	Technical Assistance
TCI	Techno Consult International
USDA-ARS	United States Department of Agriculture-Agriculture Research Services

1 INTRODUCTION

1.1 Project Background

1. Scarcity of water is one of the most critical issues of Balochistan. Despite being the country's largest province in terms of geographical area, the province is facing acute water scarcity as it lies in arid region characterized by low rainfall and frequent dry spells and persistent droughts. The increase in population and demand for economic development has resulted in indiscriminate abstraction of groundwater, which is only 9% of the total water resource available in Balochistan. Situation is rather critical in basins within the national electric grid areas, where water table is lowering at a rapid rate and depletion is posing serious concerns.

2. The Government of Balochistan (GoB) intends to address the issue of water scarcity and management of scarce water resources in the fragile environments of the province in an integrated manner and at the same time develop new livelihoods using the available surface water resources. This will reduce the dependence on scarce and diminishing groundwater resources with the support of Asian Development Bank (ADB) through the formulation of Balochistan Water Resources Development Project (BWRDP) for the Zhob and Mula river basins.

3. The Asian Development Bank (ADB) has signed a contract with the Techno Consult International (TCI) for the implementation of project preparatory technical assistance under the ADB PPTA-8800 (PAK) for the project titled 'Balochistan Water Resources Development Project (BWRDP)' under the guidance of the Government of Balochistan through the Government of Islamic Republic of Pakistan.

4. The Balochistan Irrigation Department (ID) is the executing agency (EA) and the On-farm Water Management (OFWM) Directorate General of the Balochistan Agriculture and Cooperative Department (ACD) is the implementing agency (IA). The roles of both the EA and IA are well defined in the TA Concept Note and the PPTA Assignment. The same role is described for both the agencies in the BWRDP.

5. The outcome targets of the project will be to improve land and water resources, agricultural production and farm income of 10,000 rural households by: (i) bringing 10,000 ha of new lands under cultivation; (ii) improving 20,000 ha of existing irrigated lands in terms of land and water; and (iii) protecting 1,500 ha of watersheds. The project will: (a) construct new water storage dams and Spate irrigation sub-projects (floodwater); (b) improve 300 km of canals, drains, and Karez (subsurface water channels); (c) develop a satellite-based water information system; and (d) build capacity of the local communities, the ID and ACD.

1.2 Rationale of core sub – project

6. The selection of Siri Toi Dam based on the justification that we explained in the pre-feasibility of schemes and refined outline of the engineering design to have refined cost estimates of schemes worth of US$ 93.30 million. From the scheme of US$ 93.30 million top ranking schemes worth of US$ 65.21 million will be selected for feasibility and engineering design and packaged as Core Sub-projects. Core sub-project is selected after consultation with all the stakeholders including representatives of Irrigation and Agriculture department and area notables.

1.3 Project Area

7. The proposed Siri Toi Water Storage Dam and Irrigation Project is located in Union Council Mir Ali Khel, Tehsil and District Zhob, approximately 62 km north-east of Zhob on Siri Toi River, the main tributary of Zhob River near Kili Gul Khan. The latitude and longitude of the scheme are 31° 35' 56.35" N, 69° 16' 8.86" E. The annual average availability of water is nearly 57 MCM with a catchment area of 960.5 sq.km.

1.4 Data collection and field investigations

8. Relevant data pertaining to climate, hydrology and existing infrastructure have been collected for the Feasibility Study. Primary data has been collected for the study through series of integrated field surveys.

9. Field investigation including detailed topographic survey of the dam, reservoir, command area and canal system, geotechnical investigation at the proposed dam, spillway and agricultural investigations of the command area soils have been conducted for this study.

2 TOPOGRAPHIC SURVEYS

2.1 General

10. Topographic survey of Project area provides the basis for planning of water resources projects. An accurate survey helps to plan a project, which will reflect the real picture of topography and physical features of the area. It also provides the locations of detailed physical features on ground and contours at the specified interval. It provides basic maps to develop a project layout, engineering design and quantification of project components.

2.2 Location

11. Siri Toi Dam Project site is located in District Zhob, Baluchistan. The aerial distance is about 34 km in North-West of Zhob city. Zhob – Wana road is used to approach the dam site. It's a matteled road. After 45 km, you will reach Siri Toi area, where there is a check post. From this point another matteled road is turning left, which goes to Killi Hazrat Baba. Killi Hazrat Baba lies within the potential command area of proposed dam. After a Killi Hazrat Baba, only kacha track is found to reach to the site. The total distance from Siri Toi check post to dam site is about 20 km. Only 4x4 vehicle could reach the site due to the rough terrain. Coordinates for the proposed dam site is 31°35'58.52" Lat, 69°16'10.62" Long. Siri Toi is the main river flowing from south to north and empties into to Zhob River at the length of 130 km. Siri Toi River is like a shifting snake, twisting to find its easiest way down to Zhob River. Two main tributaries contributing and form a Siri Toi River are Tangi Manda & Chukhan Manda. The watershed of Siri Toi River from start to proposed dam axis is around 968 sq.km.

2.3 Topographic Survey

12. Surveying is considered a vital link in the process of obtaining quality engineering in the Planning and design of projects. An initial planning for survey was essential as other studies and investigations depend on the availability of accurate topographic maps of the area depicting all essential existing features. At first SOP (Survey of Pakistan) sheets were collected and initially utilized for obtaining topographic information for preliminary reconnaissance survey. Following SOP sheets are used for reconnaissance survey;

- SOP SHEET NO 39-A/15 Scale 1: 50,000
- SOP SHEET NO 39-A/16 Scale 1: 50,000
- SOP SHEET NO 39-E/2 Scale 1: 50,000
- SOP SHEET NO 39-E/3 Scale 1: 50,000
- SOP SHEET NO 39-E/4 Scale 1: 50,000
- SOP SHEET NO 39-E/6 Scale 1: 50,000

13. These were also used to calculate the project area and to identify the main feature within the project vicinity. After preliminary study of Siri Toi Dam Project Site, reconnaissance survey had been carried out on 22nd of April 2017 through latest handheld GPS. In reconnaissance survey all previously identified features, topography and local informational had been verified. Demarcation of project boundary had also been covered in reconnaissance survey. All planning and design surveys were planned, scheduled, and directed to meet the engineering requirements. Siri Toi project site contains plain to highly and barren to cultivated land. Surveying plan had been prepared by keeping this in to consideration. All the survey work had been supervised by the experienced survey engineer. The total proposed area for survey was worked out at 26,800 acres, including reservoir and command area. The

topographic survey was proposed on scale of 1: 4000 and contour interval of 1m. The surveyor was required to provide the results in the form of soft and hard copies according to the specified format. For better planning and physiographical understanding, a high tech drone had been used. Base Mapping had been done by acquiring aerial images.

2.4 Horizontal & Vertical Control

14. World Geodetic System (WGS 84) is the reference datum for the horizontal and vertical control. While Universal Transverse Mercator (UTM) conformal projection that is uses 2-dimensional Cartesian coordinates system is used to obtain and plot survey data. Measurement with accuracy is the main key of surveying. To maintain the survey accuracy highly precise, popular and versatile TOPCON GR-5 dual frequency differential GPS had been used.

- STATIC H: 3.0 mm + 0.5 ppm V: 10.0 mm + 1.0 ppm
- RTK H: 10.0 mm + 1.0 ppm V: 20.0 mm + 1.0 ppm

15. At first survey team had performed the triangulation with HIGH PRECISION GPS and secondly established survey control points throughout the project area. For GPS triangulation the project area had been covered with 5 GPS points. Points were installed at such places that could cover the complete project area. Each point had been observed minimum 2 hrs. Post processing had been done with TOPCON TOOLS and SPECTRUM SURVEY OFFICE. After post processing and adjustment of DGPS data, these coordinates are then used for traverse closing. Leica FlexLine TS-06 EDM with 1” second accuracy is used for traversing. A close traverse technique by measuring a distances in two direction (forward and back) had been used to maintain + 3 mm accuracy. After installation and primary BMs network, subsequently control point had been established throughout the project area by using 1 base and 3 rovers. Each control point had been observed around 1 hrs. These points were also traverse for the secondary control points. To maintain the vertical accuracy double leveling had been carried out to transfer the accurate level to the control points in first standard farm. Nikon 32x level machine had been used along with standard quality and compatible metric leveling staves. The traversing errors and corrections had been adjusted at site. Then, corrected references have been used for detailed topographic survey.

2.5 Reservoir Area

16. Detailed topographic survey of a reservoir area had been carried out through latest total station, Sokkia CX 105, with 5” second accuracy. Two survey parties with 11 field workers each, had been mobilized to cover 411.20 acres of reservoir area. 5m x 5m survey grid had been proposed to cover the reservoir area, while significant elevation difference was also cover during topographic survey. Proposed Dam Axis, Dykes and Spillway had been cover with 1m x 1m grid and any other points in between with elevation difference of 300 mm or more had also been cover during topographic survey. Cross section had been taken at the proposed structure including dam, dyke and spillway.500 m wide corridor was observed during survey, where data density varies from sub meter or less but not more than 3m.

17. In the reservoir area spot elevations were taken at every 15-20m interval to establish an accurate Digital Terrain Model (DTM). The random elevations were surveyed which fully depict the existing terrain conditions on the ground. All physical features have been surveyed. Survey was carried out to an overall accuracy of ± 0.01 m in x, y, z directions. The field data was stored in the instrument and later on down loaded to the computer at site. The data was reviewed at site to ensure presence of all important features. River bed level at the proposed

dam axis was measured 1396m, proposed crust level of the main dam axis was 1462m decided by the design engineer. Reservoir survey had been done to close contour at 1470m. Reservoir area is consists of shape sloppy barren hilly. Perennial flow are always present in the reservoir area but due to the high elevation banks and narrow river bed, cultivation is scarce. Nearest village is Killi Hazrat Baba, the aerial distance between proposed dam axis and Killi Hazrat Baba is around 6.5 km. There is no settlement in the reservoir area, which endanger to submergence.

2.6 Command Area

18. Command area had been surveyed by setting out 3m x 3m grid & elevation difference of 500 mm had also been observed as a spot elevation. The total command area is about 26349 acres. It was a big command area and required much more details than reservoir area, so it was plan to engage minimum four survey parties. A single survey party equipped with total station and 6 field crew had been mobilized to perform the cross section survey along the proposed channel alignment. Survey had been done to cater the 50 km total length of proposed channel. Detailed cross section of a proposed channel had been taken at every 25m distance and at every elevation difference of more than 1m for a corridor width of 10m. All roads and drainage crossing along the proposed alignment of irrigation network had been covered through cross section method. The cross section interval for the road and drainage crossing had been taken 50m upstream and 50m downstream and at every 5m interval and at every elevation difference of more than 1m. Real-time kinematic surveying had been done to survey the jeep able land, this includes roads, tracks, and plain areas. 3D survey of existing structure had been done with total station machine, all the existing structure including type of structure, material used, all relevant levels and measurements and condition of structure with detailed topography had been and marked in the drawing. The survey density for the 3D survey was 1m x 1m. A dedicated survey party performed the detailed survey for the existing structure. Easting, northing and elevation were measured in the field, later observed data was processed in thematic layers format using suitable software and computer aided line mapping carried out. It was plotted and verified on site for any missing/inaccurate information. Contour map was developed with major contours at 5 m interval and minor contours at 1 m interval.

2.7 Working / Completion Period

19. The field work was started in the third week of Apr 2017 and the digital mapping processed and completed on May 20, 2017.

2.8 Establishment of Permanent Bench Marks

20. Permanent Concrete Benchmarks were established, inside project boundary for future reference. The locations of benchmark were selected at such places, which are not susceptible to disturbance or damage. The location, bearings and levels of BM, were determined and shown on layout drawings. Total 5 permanent BMs had been established in the project area, whereas 25 control points were established during the survey.

2.9 Survey Instruments

21. The following survey instruments had been used for the baseline and topographic survey of BWRDP Project.

Survey Teams	5
Survey Crew	45
DGPS (*TOPCON* GR-5)	2 Sets
Total Stations (*SOKKIA CX* 105)	2
Total Stations (*SOKKIA* 630-R)	2
Total Stations (*Leica TS-06*)	1
Drone (Phantum 4Pro)	1
Survey Vehicles	5
HandHeld GPS (Garmin)	6
Level Machines (NIKON 32x)	2

2.10 Software Used

22. Following software had been used for data processing and map making.

- Prolink.
- Eagle Point 2009.
- AutoCAD 2008.
- Global Mapper 13.
- Google Earth Pro.
- ArcGIS 10.
- ERDAS Imagine 9.2.
- TOPCON Tool
- Drone Deploy.

23. Prolink had been used for data download form total station to computer in *.sdr file format. After processing and adjustment the data had been uploaded into the Eagle Point. Triangulation and contouring had been done in eagle point environment by using the surface modeling module. Index interval of contours had been adjusted to 5 m and intermediated is equal to 1 m .Global mapper (Ver 15) had been used for navigational purpose during the field survey, it had been used to verify the previously identified features by doing real time tracking with integration of handheld gps with laptop computer.

24. Google Earth Pro had been used throughout the survey planning, field navigation.

25. ArcGIS and Erdas Imagine had been used in the geo-referencing of SOP Sheets

2.11 List of Permanent Benchmarks.

i	BM-1	E 528354.206	N 3497843.027	Z 1423.436
ii	BM-2	E 526286.144	N 3495885.421	Z 1435.757
iii	BM-3	E 534599.719	N 3500298.248	Z 1272.580
iv	BM-4	E 534307.131	N 3500972.188	Z 1306.069
v	BM-5	E 538752.862	N 3503944.269	Z 1230.703

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3 HYDROLOGY CURRENT WATER BALANCE

3.1 General

26. Hydrological studies are required to ascertain climatic characteristics of the project area, quantification of water available for development and evaluation of spillway design flood. Climatic features such as temperature, evaporation, wind speed, solar radiation and rainfall define the area in the rational terms while stream flow data including its consistency indicates the amount of available water in the system.

27. Following tasks have been carried out:

- Rainfall frequency analysis
- Estimate of long term Inflows at the proposed dam site
- Water availability and reservoir size
- Determination of Design Flood
- Estimate of sediment inflow and useful life of reservoir

3.2 Location

28. The Siri Toi water storage dam site is located in the Union Council of Mir Ali Khel, tehsil and district Zhob, about 62 km north-east of Zhob on Siri Toi river, the main tributary of Zhob river near Kili Gul Khan. The latitude and longitude of the sub-project are 31° 35’ 52” North, 69° 15’ 58” East and the mean altitude of the command area is 1350 m above mean sea level. Catchment area map is shown as Fig. 1.

3.3 Climatic Features

29. The climate of Zhob is very cold in winter as compared to other lower basins of Balochistan. The Siri Toi site located at an elevated north eastern part of the Zhob basin has intense winters with the mercury dropping below zero degrees Celsius (0 ºC). The coldest months are generally December and January. The summer in general is warm to hot with the temperature reaching up to 30 to 35 º C in June, July and August. The monthly temperature data for the years (1979-2014) is given Table-1 below.

Table 1 - Mean Monthly Temperature (ºC) Near Siri Toi Dam

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
0.2	1.3	5.2	12.6	20.4	30.5	31.8	27.8	23.1	18.6	7.1	0.5

30. The evaporation rate in the project area varies from 150 mm to more than 360 mm in the months of January and August respectively. The monthly pan evaporation data for the years (2002-2009) is given Table-2 below.

Table 2 - Pan Evaporation (mm)

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
149.42	149.51	212.69	278.42	358.01	346.52	360.68	363.98	333.31	278.86	198.02	167.42

3.3.1 Rainfall

31. Six rain gauging stations are available in and around the Zhob catchment namely Zhob, Badinzai, Sharan Jogezai, Qilla Saifullah, Muslimbagh and Murgah Kibzai. However, only three stations influence the catchment of Siri Toi Dam that include Zhob, Badinzai and Sharan Jogizai. No rainfall station lies within the Siri Toi catchment boundary. The areal weightages of the three stations Sharan Jogezai, Badinzai and Zhob computed by thiessen polygons are 0.065, 0.289 and 0.646 respectively. The areal rainfall computed by thiessen polygon for the period of 1979-2015 gave an average annual depth of 248 mm.

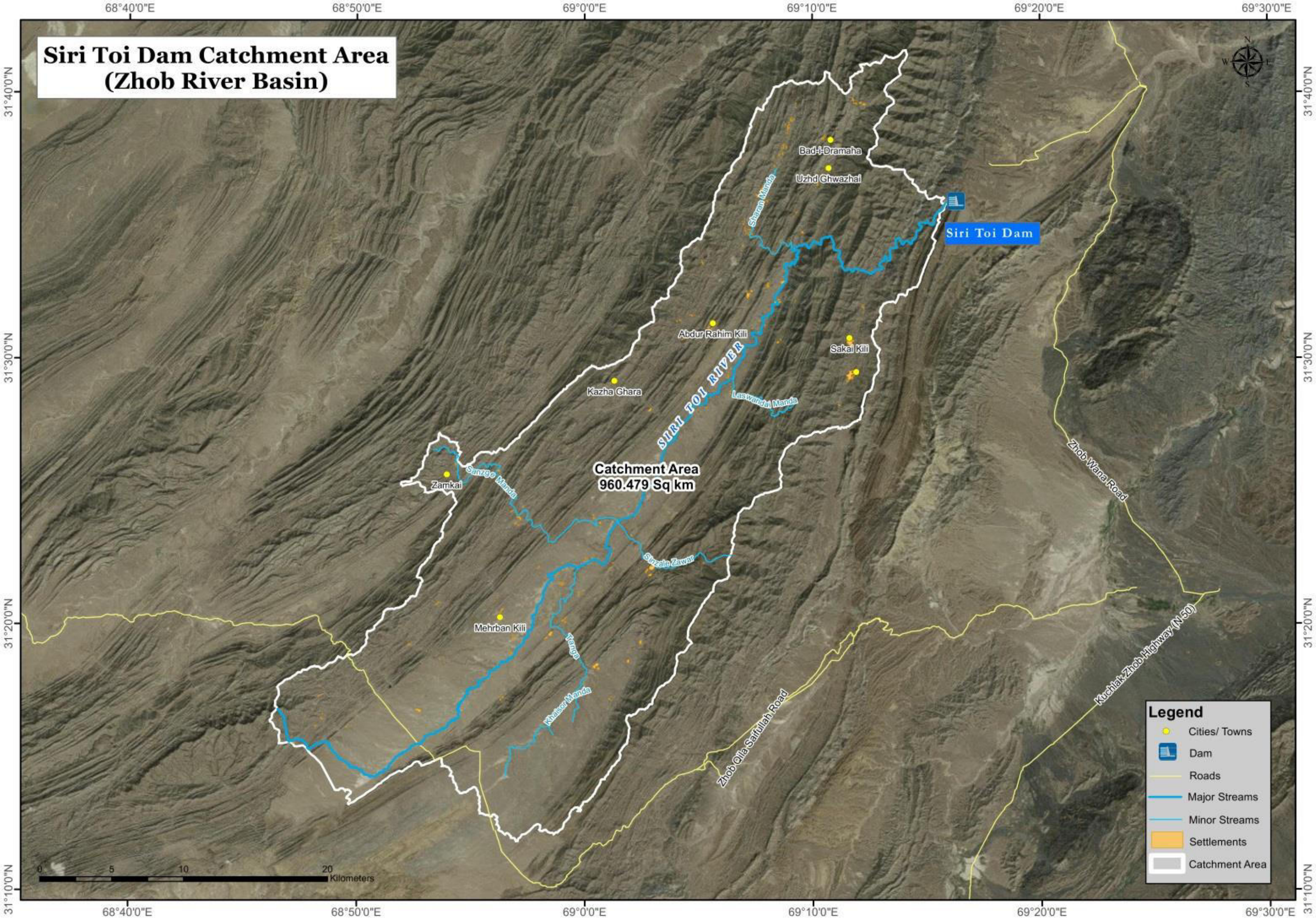


Figure 1 - Siri Toi Catchment

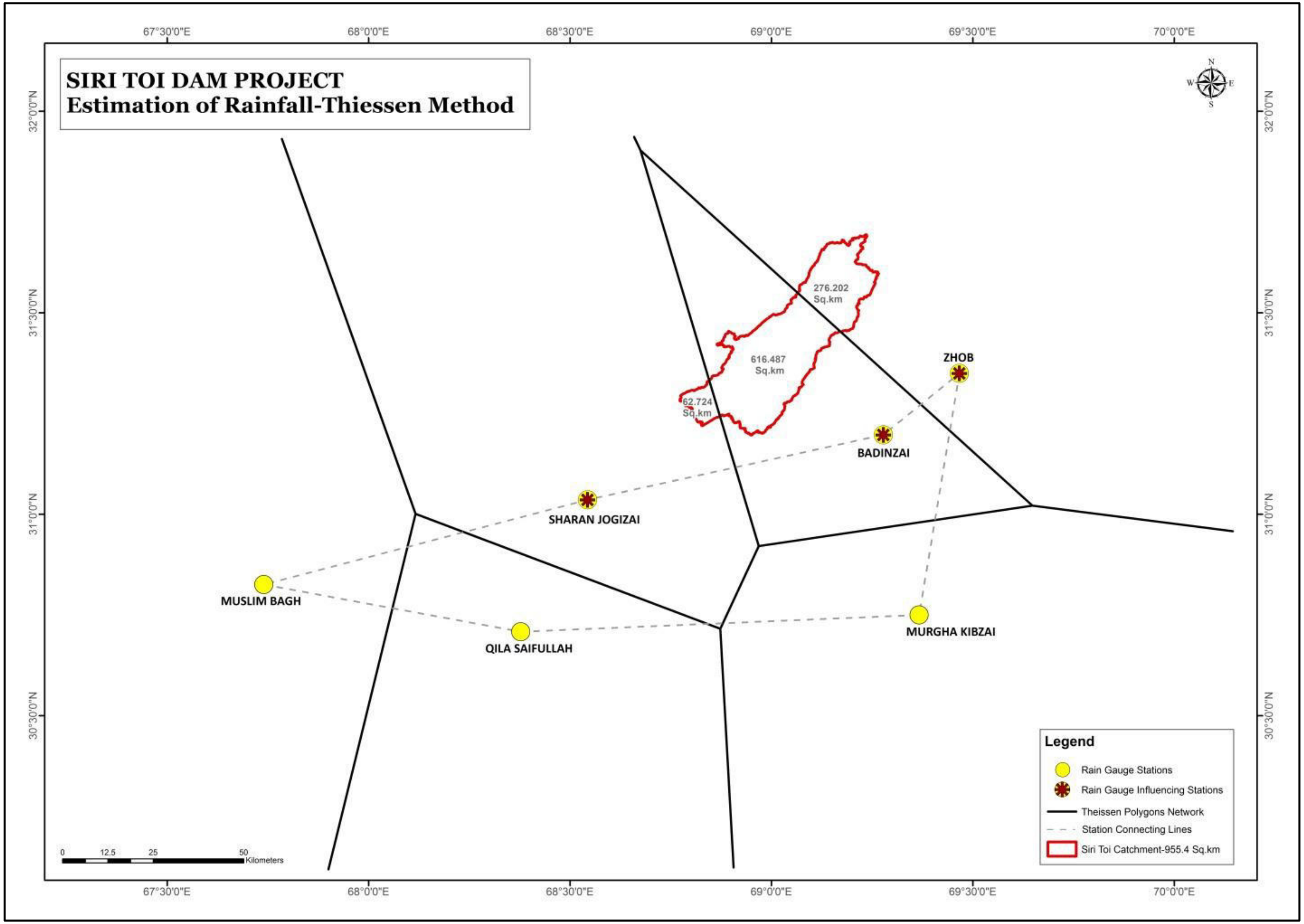

SIRI TOI DAM PROJECT
Estimation of Rainfall-Thiessen Method
67°30'0"E
68°0'0"E
68°30'0"E
69°0'0"E
69°30'0"E
70°0'0"E
32°0'0"N
31°30'0"N
31°0'0"N
30°30'0"N
276.202 Sq.km
616.487 Sq.km
62.724 Sq.km
ZHOB
BADINZAI
SHARAN JOGIZAI
MUSLIM BAGH
QILA SAIFULLAH
MURGHA KIBZAI
Legend
Rain Gauge Stations
Rain Gauge Influencing Stations
Theissen Polygons Network
Station Connecting Lines
Siri Toi Catchment-955.4 Sq.km
0 12.5 25 50 Kilometers

Figure 2 - Rainfall Gauging Stations for Siri Toi Catchment

32. The rainfall gauging stations around the catchment are shown in Figure 2. The monthly average areal Rainfall for the period of 1979-2015 is shown in Table-3

Table 3 - Annual Areal Rainfall in mm for Siri Toi Dam (1980-2014)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1980	19	24	99	4	5	10	9	9	4	26	8	6	224
1981	24	36	59	9	25	0	48	12	0	7	0	1	221
1982	30	45	97	32	135	1	3	110	0	40	14	33	540
1983	11	24	27	93	23	0	80	62	0	0	0	11	331
1984	4	8	15	21	2	16	74	189	2	0	3	11	345
1985	18	6	16	36	9	0	167	100	0	4	4	11	371
1986	5	35	74	25	8	5	13	126	0	0	14	1	305
1987	6	37	67	10	58	9	23	24	0	0	0	0	235
1988	19	15	34	22	0	3	132	69	4	0	0	19	319
1989	8	17	100	15	1	4	68	16	0	0	5	23	258
1990	30	50	33	28	39	5	38	36	8	0	8	23	298
1991	23	28	52	95	29	19	4	8	26	1	11	13	308
1992	37	36	24	65	14	3	11	28	8	2	7	11	245
1993	17	16	28	30	10	5	22	0	0	0	0	1	128
1994	15	54	36	25	15	17	99	72	6	9	3	6	356
1995	19	17	65	65	1	7	63	20	0	2	1	18	277
1996	49	16	36	7	21	13	15	5	0	3	1	11	176
1997	20	6	52	58	13	4	24	10	0	72	24	24	305
1998	17	50	64	27	10	6	19	0	12	0	0	0	206
1999	26	32	17	0	41	0	4	54	0	0	1	0	176
2000	10	20	16	0	0	0	25	1	1	0	1	10	84
2001	6	7	22	36	0	3	21	8	1	0	0	6	109
2002	1	33	20	27	0	4	0	12	0	5	48	14	164
2003	4	18	14	9	0	0	31	20	7	0	2	1	107
2004	30	8	0	7	1	0	4	6	1	6	10	25	97
2005	32	64	69	8	10	1	31	19	14	0	1	1	251
2006	22	19	34	3	0	11	22	59	4	0	53	42	269
2007	5	50	20	5	1	14	19	7	0	0	0	8	129
2008	17	15	2	18	3	12	16	13	3	0	0	27	126
2009	36	16	15	12	3	1	41	0	12	0	1	10	146
2010	12	18	25	37	40	7	123	304	7	6	0	5	582
2011	4	33	13	25	1	0	14	22	70	4	17	0	202
2012	12	21	9	59	2	11	40	82	18	0	0	29	284
2013	1	44	49	27	2	53	1	141	8	0	12	0	338
2014	1	36	46	57	17	1	4						163
Avg.	17	27	39	29	15	7	37	48	6	6	7	12	248
Max.	49	64	100	95	135	53	167	304	70	72	53	42	582
Min.	1	6	0	0	0	0	0	0	0	0	0	0	84

3.4 Water Availability
3.4.1 Regional Analysis for Water Availability

33. Zhob River basin has several ancient karez systems that have been a vital source of irrigation and domestic water for the past several centuries. However, with the increase of groundwater abstraction through pumping rapid depletion of water table in recent years is observed, causing these systems to be dysfunctional. Within the Siri Toi catchment, river reaches have perennial subsurface flow running below the river bed throughout the year, while some short reaches have water appearing on the surface. The steep and mountainous terrain causes the streamflow to increase substantially soon after the occurrence of rainfall in the catchment area. During heavy rainfall substantial damage has occurred as a result of flash

floods generated from the steep mountain slopes in the upstream catchment area. Due to lack of water infrastructures the surface water potential, for this part of Zhob basin, is not fully exploited. At present, a huge cultivable portion of land downstream of the proposed dam site is barren. Presently, some kilometers downstream of the site flow is diverted by farmers only during moderate to high flow season through locally constructed dykes with no proper storage structure. In other parts of Zhob majorly irrigation relies on tubewells where groundwater has been excessively over drafted over the past years particularly for irrigation of orchards located in Muslimbagh and Qilla Saifullah sub-basins.

34. The annual average water availability at Siri Toi Dam is 57 MCM. However, for design purpose of the design command area, 50% probable water availability of 39.79 MCM is considered. The results are obtained by a hydrological model generated on Soil and Water Assessment Tool (SWAT) developed by United States Department of Agriculture (USDA). The average monthly inflow for Siri Toi estimated from the model is shown in Table-4.The detailed methodology of the model study was discussed in a separate Water Balance Report submitted during month of April 2017.

Table 4 - Annual Inflows at Siri Toi Dam in MCM (1980-2014)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1980	0.34	4.34	26.03	1.47	1.05	0.73	0.60	0.60	0.48	0.33	0.47	0.31	36.75
1981	0.23	0.57	17.48	5.22	3.93	0.78	6.77	12.64	5.19	0.95	0.46	0.34	54.57
1982	0.26	7.60	30.85	23.40	10.59	1.68	0.68	0.84	0.54	0.45	0.44	1.00	78.33
1983	2.12	1.52	1.46	42.42	24.77	5.55	1.00	26.21	9.52	3.19	0.61	0.45	118.83
1984	0.35	0.24	0.19	0.20	0.14	0.12	17.02	36.62	24.53	8.02	2.53	0.70	90.65
1985	0.50	0.41	0.30	0.29	0.20	0.11	2.34	1.58	0.49	0.33	0.22	0.17	6.94
1986	0.15	0.13	0.54	0.67	0.58	0.36	0.28	0.25	0.15	0.10	0.07	0.09	3.38
1987	0.07	0.56	10.76	4.92	3.89	1.80	0.59	8.13	1.10	0.43	0.29	0.21	32.74
1988	0.18	0.15	4.25	2.21	0.64	0.29	0.37	13.26	10.35	2.56	0.53	0.42	35.22
1989	0.41	0.27	10.16	39.84	9.87	1.44	1.67	6.88	1.93	0.55	0.37	0.66	74.06
1990	15.98	17.45	14.23	14.97	6.60	1.01	0.60	3.47	3.48	3.90	0.90	1.08	83.66
1991	14.01	25.69	38.73	66.65	28.30	12.79	9.38	1.93	1.10	1.15	0.66	0.45	200.85
1992	2.29	16.69	10.71	21.11	14.55	2.49	0.72	0.56	0.39	0.29	0.20	0.19	70.18
1993	0.19	0.14	0.53	0.42	0.33	0.20	0.16	0.11	0.06	0.04	0.02	0.02	2.22
1994	0.04	9.47	1.91	0.90	0.69	0.47	0.65	0.99	0.64	0.43	0.33	0.23	16.74
1995	0.22	0.24	7.25	2.74	11.89	3.55	3.95	6.10	0.90	0.47	0.32	0.30	37.92
1996	9.82	8.36	7.74	2.08	0.50	0.39	0.30	0.22	0.13	0.09	0.06	0.11	29.80
1997	0.16	0.21	0.58	1.05	1.22	0.97	0.48	0.40	0.26	5.73	10.02	18.37	39.44
1998	9.47	10.31	44.27	12.73	2.83	0.74	0.58	0.39	0.29	0.24	0.16	0.11	82.14
1999	0.15	10.47	16.16	4.08	0.97	0.79	0.44	2.14	0.81	0.37	0.26	0.19	36.84
2000	0.21	0.30	0.26	0.17	0.10	0.05	0.07	0.07	0.03	0.02	0.01	0.03	1.31
2001	0.02	0.01	0.02	0.14	0.17	0.07	0.09	0.21	0.10	0.05	0.02	0.03	0.92
2002	0.03	0.04	0.50	0.36	0.23	0.13	0.08	0.06	0.05	0.03	41.36	1.21	44.09
2003	0.93	1.47	1.12	0.97	0.75	0.48	0.40	0.41	0.23	0.15	0.11	0.08	7.09
2004	0.53	1.31	0.44	0.27	0.19	0.12	0.08	0.05	0.03	0.06	0.05	1.39	4.54
2005	10.99	3.32	19.48	25.34	10.98	1.85	1.00	0.73	0.52	0.39	0.28	0.21	75.09
2006	0.27	1.09	3.56	0.83	0.51	0.33	0.25	20.54	13.67	3.87	15.44	35.46	95.83
2007	12.96	35.75	54.35	23.89	6.66	1.42	1.95	0.94	0.61	0.44	0.30	0.33	139.59
2008	0.59	11.70	7.91	15.35	4.49	0.64	0.46	0.46	0.30	0.20	0.13	1.10	43.33
2009	13.02	29.18	13.04	7.93	1.35	0.58	0.42	0.30	0.21	0.15	0.12	0.14	66.45
2010	0.16	0.23	0.58	0.40	0.81	0.43	20.06	155.43	49.96	18.34	6.48	1.94	254.80
2011	0.88	18.56	30.97	22.81	11.25	1.69	0.75	0.60	2.67	0.98	0.57	0.34	92.08
2012	0.25	0.20	0.20	0.34	0.38	0.31	0.44	3.49	2.20	0.40	0.25	0.23	8.68
2013	0.18	0.66	5.19	14.19	3.09	0.59	0.51	0.43	0.67	0.34	0.22	0.16	26.23
2014	0.11	0.38	5.24	9.73	3.84	0.43	0.34	-	-	-	-	-	20.07
Avg.	2.80	6.26	11.06	10.57	4.81	1.30	2.16	8.77	3.82	1.57	2.41	1.94	57.47
Max.	15.98	35.75	54.35	66.65	28.30	12.79	20.06	155.43	49.96	18.34	41.36	35.46	254.80
Min.	0.02	0.01	0.02	0.14	0.10	0.05	0.07	0.05	0.03	0.02	0.01	0.02	0.92

3.4.2 Rainfall Frequency Analysis

35. Rainfall data for the period of 1979 to 2015 was analyzed for one-day maximum values. Maximum daily values for three stations Zhob, Badinzai and Sharan Jogizai were analyzed with log Pearson type III and Gumbel Extreme Value Type I. The maximum one day value is 72.9 mm recorded in the year 2010. As a result of the analysis, the best fit distribution system has been assessed to be the Gumbel Extreme Value Type I. The magnitude of 10,000 year return period storm is 139 mm (5.48 inches).

Table 5 - Computed Storms for Various Return Period

S. No.	Return Period	Design Precipitation	
		mm	Inches
1	10,000 Years	139.06	5.48
2	1000 Years	108.17	4.26
3	500 Years	98.87	3.89
4	200 Years	86.56	3.41
5	100 Years	77.23	3.04
6	50 Years	67.87	2.67

3.5 Flood Studies for Design of Spillway

3.5.1 Design Flood and Storm

36. The criteria proposed by F.F Snyder, has been adopted for the selection of the design flood. The following Table 6 Gives the criteria for the selection of design flood.

Table 6 - Snyder's Inflow Design Flood Criteria

Category	Impoundment Danger		Failure Damage Potential		Spillway Design Flood
	Storage (MCM)	Height (m)	Loss of Life	Damage	
Major	>100	>25	Considerable	Excessive	Probable Maximum Flood (PMF)
Intermediate	1.25-62	12-25	Possible but Small	Within Financial capability of owner	Standard Project Flood (SPF)
Minor	<1.25	<12	None	Equal to cost of dam	50-100 Year Return Period

37. The storage of Siri Toi Reservoir is 36.49 MCM and the height is 66 m. Therefore, the Spillway will be designed on PMF. As data required for Probable Maximum Precipitation (PMP) and Probable Maximum Flood (PMF) design for this region is not available the statistical Hershfield's PMP approach has been used.

38. Spillway design inflows for dams as high as Siri Toi (66-m) are designed either on Probable Maximum Flood (PMF) or 10,000-year return period flood depending on the location characteristics, reliability of data available, annual exceedance probabilities (AEP) and project economics[1,2]. To estimate the Probable Maximum Precipitation (PMP) for Siri Toi, the widely used Hershfield's statistical method is used. In basins with limited hydro-meteorological data this method has been widely used and accepted around the world. The procedure to estimate the PMP adopted for the Siri Toi catchment is explained in the publication by World Metrological Organization (WMO)[3].

1 Ross D. Zhou., C. R. Donnelly and David G. Judge. 2008. "On the Relationship between the 10,000 year flood and Probable Maximum Flood". Hydrovision -HCI Publications.

2 USACE EM-1110-2-1402 "Hydrological Engineering Requirements for Reservoirs "

3 Manual on Estimation of Probable Maximum Precipitation (PMP), WMO No. 1045. (2009).

39. The Siri Toi PMP determined statistically by the Hershfield's method is nearly twice the magnitude of 10,000 year return period flood. For economic reasons, the Siri Toi spillway is designed for an inflow design flood of 10,000 years with a freeboard of 2.5-m up to the dam crest. However, to ensure dam safety against future extreme floods due to climate change the dam freeboard is raised by providing additional RCC parapet walls of 1.5-m height above dam crest, dyke and spillway approach walls. With the provision of additional freeboard the spillway will be capable to release the PMF discharge at a static head of 4.92-m without overtopping and risking the dam safety.

40. The parapet walls are intended only to provide additional freeboard against wave run-up and wind fetch and are not designed to accommodate surcharge head. This design intervention is also adopted as a specific climate change adaptation to reduce future risks and vulnerabilities.

Table 7 - Summary of Results

Return Period	24 hr - Rainfall (mm)	24hr - Rainfall (in)	Flood (cumecs)
10,000	139.07	5.48	2,188
PMF	275.75	10.86	4,946

3.6 Flood Studies

41. This section discusses in detail the approach adopted for estimation of the rainfall runoff relationship, generation of flood hydrograph and routing the same through the Siri Toi dam reservoir and spillway

3.6.1 Estimation of Flood Peak/ Flood Hydrograph

42. The Soil Conservation Service (1972) method has been used to compute abstractions or losses from storm rainfall. The SCS formula has been based on work done on a large number of watersheds. It takes into account the various factors affecting runoff from watersheds like type of soil, vegetation and land cover and antecedent moisture contents etc. The method divides soil into four hydrological soil groups A, B, C and D corresponding to low, moderate, high and very high runoff generation rates respectively. Similarly vegetal cover has been classified into various categories like cultivated land, rangeland, meadow, wooded forest etc. Antecedent moisture conditions (AMC) are classified as AMC I, II and III. This classification depends upon 5 day antecedent rainfall prior to the day for which runoff is being considered. The formula for computation of excess rainfall is given as follows:

$$Pe = \{(P-0.2S)2\} / \{P+0.8S\}$$
$$S = 25400/CN-254$$

Where,

Pe = Runoff/Excess Precipitation, mm
P = Total precipitation, mm
S = Potential maximum storage retention in mm

43. Based on the geology, soil, slope and vegetation cover data available for the catchment the CN has been estimated as 90 for AMC condition II and the corresponding soil retention is 1.11 inches. The average basin slope of the catchment is very steep at 20-25% while the land is mostly barren.

3.6.2 Time of Concentration

44. The time of concentration (Tc) of a watershed defines the magnitude of flood peak that can be achieved as a result of a storm event. Tc is the time required for the hydrologically most remote drop of rainfall to reach the watershed outlet. Tc is based storm distribution over the watershed area and on topographical characteristics like longest flow path, terrain steepness etc. The Kirpich (1940) equation defined in USBR Design of Small Dams is used to estimate Tc:

$$T_c = (11.9 \times L^3/H)^{0.385}$$

Where,

L = Longest flow path, miles
H = Elevation Difference, ft
T_c = in hours

45. Based on the longest flow path of 95 km (59.05 miles) and elevation difference of 1215 m (3986 ft) in Siri Toi catchment has a time of concentration Tc equal to 11.85 hours.

3.6.3 Design Storm/rainfall

46. Storm duration of 24 hr have been used for the development of synthetic storm hydrograph using SCS Design rainfall transformation Method. Since SCS design storm distribution is applicable to United States and similar climatic regions only, so design storm temporal distribution as estimated for Balochistan by Wirasat Ullah (1980) corresponding to 24 hr rainfall is used for the estimation of design flood of Siri Toi Dam.

Time Distribution of excess rainfall

47. The distribution curve is similar to SCS Type II distribution however; the major portion of rainfall accumulates in the early hours (0-6 hr) of the 24-hr period instead of the mid-day (8-12 hr) accumulation in SCS type II storm distribution. The 24-hr rainfall distribution is graphically shown below:

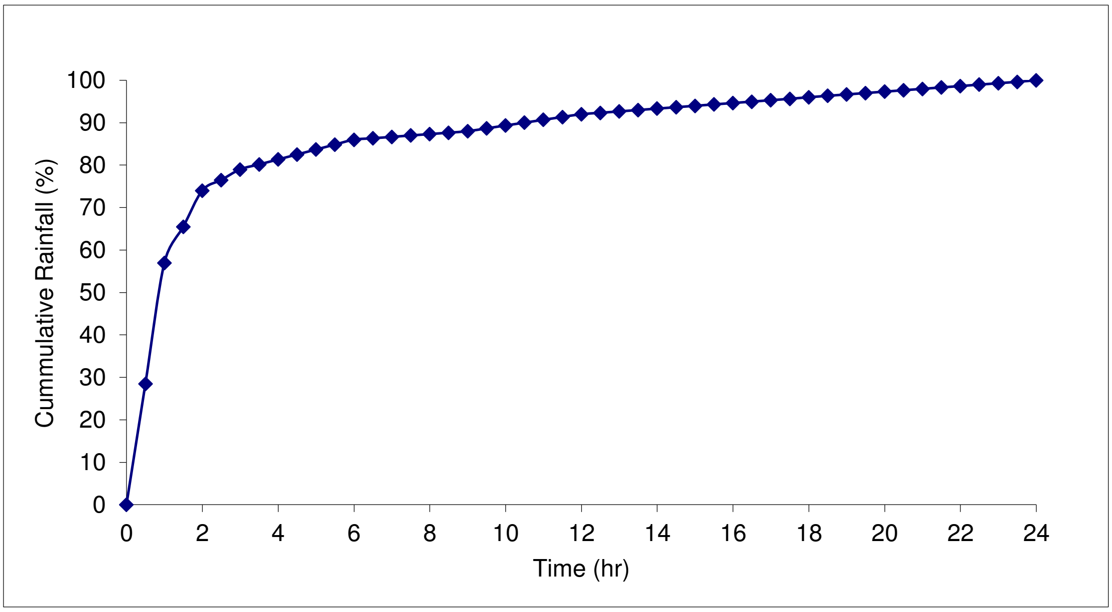


Figure 3 - Hourly Distribution of Rainfall near Siri Toi Catchment

3.6.4 Transformation Method (Unit Hydrograph to Flood Hygrograph)

48. The SCS dimensionless unit hydrograph method is used to obtain a unit hydrograph of Siri Toi watershed based on time to peak (Tp) and peak discharge (Qp). The equation for Tp and Qp are given as:

$$T_p = 0.5\ D + 0.6\ T_c$$

Where,

T_c	=	time of concentration, hr
D	=	duration of unit Hydrograph, hr

49. The duration of unit hydrograph (D) is taken as 0.133 times Tc which resulted in a Tp equal to 2 hrs. The time of peak was computed as 8.1 hrs. The unit hydrograph peak discharge is based on the time to peak and watershed area which is expressed as:

$$Q_p = 484\ A / T_p$$

Where,
A = drainage area, sq. miles
T_p = hours

50. Unit hydrograph peak ordinate Qp for Siri Toi is 22,385 cusecs/inch. The unit hydrograph is transformed into a storm hydrograph by the method of convolution (Chow, 1987) which gave a peak of 2,188 (77,091 cusecs) for a 10,000 year return period storm event.

3.6.5 Spillway Rating

51. An un-gated ogee spillway is designed for Siri Toi Dam. The spillway is designed for 10,000 year flood. The design head is 3.6-m with a crest length of 135-m. The spillway crest level is set at 1456-m. The rating curve of the spillway is given below.

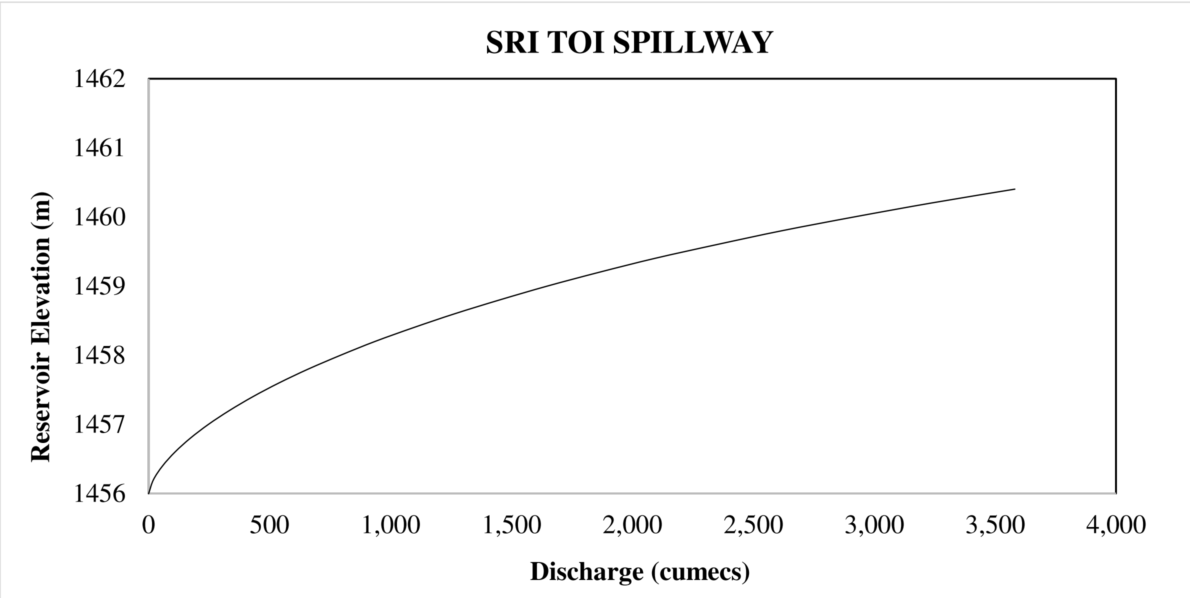


Figure 4 - Spillway Rating Curve of Siri Toi Dam

3.6.6 Flood Routing/Inflow and Outflow Hydrographs

52. Flood routing study is carried out for the design inflow flood (10,000 years) of 2,188 cumecs considering the reservoir level at maximum conservation level. A surcharge head of

3.45 m will occur above the ungated ogee crest with a peak outflow of 2,158 cumecs. The approach velocity head is 0.47-m at design outflow. The maximum total head over the spillway crest is 3.92-m. The maximum reservoir level will reach up to 1459.45-m. As the surcharge storage above the spillway crest is not significant compared to the inflow volume the design inflow flood peak magnitude will not attenuate and delay significantly and the difference between inflow and outflow is only 30 cumecs.

53. Similarly to ensure dam safety and climate change vulnerability flood routing for PMF (4,946 cumecs) is also carried out. A surcharge head of 4.91 m will occur above the ungated ogee crest with a peak outflow of 4,933 cumecs. The approach velocity head is 1.42-m at PMF outflow. The maximum total head over the spillway crest is 6.34-m. The maximum reservoir at PMF will reach up to 1460.91-m. For additional freeboard against wave action and wind run-up at PMF parapet walls have been provided on the dam, dyke and spillway approach walls. The graphical representation of flood routing is shown in **Error! Reference source not found.** and Figure 6:

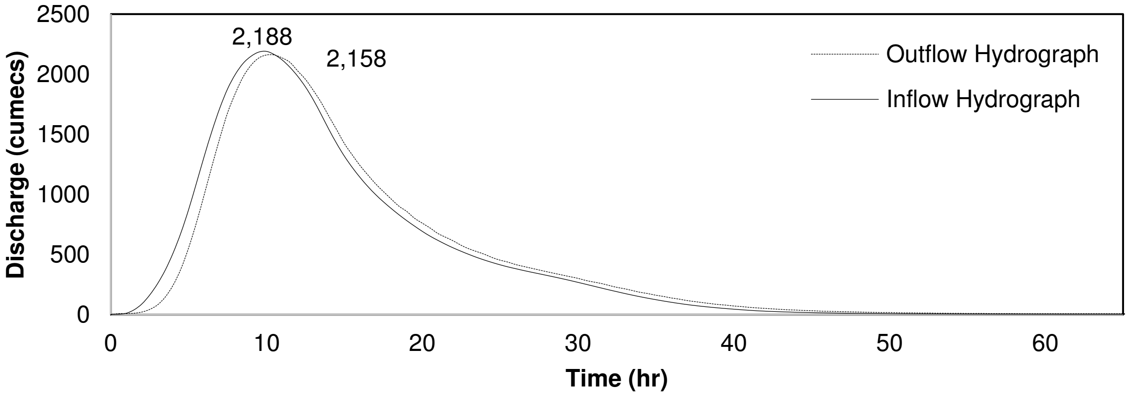


Figure 5 - Inflow and Outflow Hydrograph of Design Flood (10,000-year) through Siri Toi Reservoir

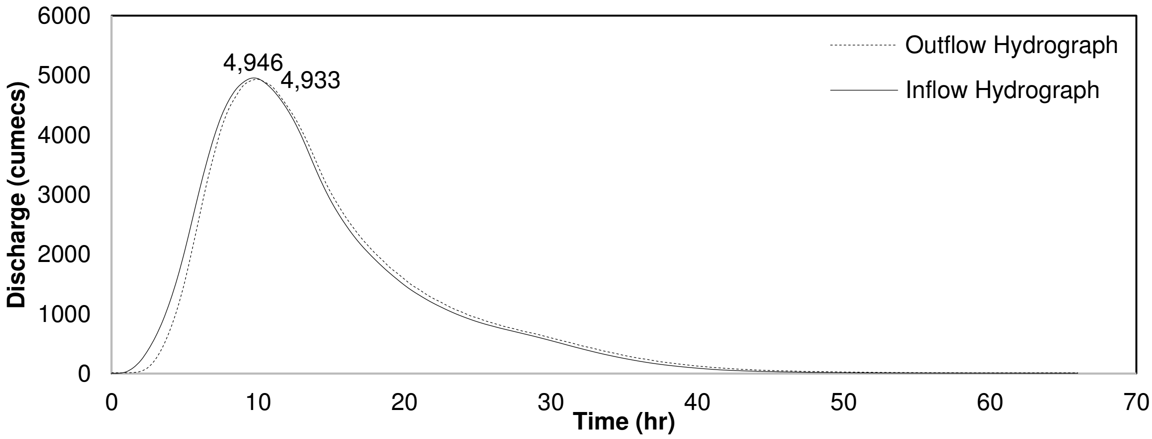


Figure 6 - Inflow and Outflow Hydrograph for PMF through Siri Toi Reservoir

3.7 Reservoir Operation Study

54. Reservoir operation studies have been performed for 8 years on monthly time steps for the design command area of 4027 hectares using the time series data for catchment rainfall, inflow, pan evaporation, irrigation demand to estimate the yield (actual releases) of the reservoir. A spreadsheet has been developed which carries out the simulation of the reservoir water balance using the monthly time interval t, t = 1,2,3,......,T. The water balance equation can be written as follows:

$$S_t = S_{t-1} + I_t - Y_t - A_t .e_t - Q_t$$

Where
S_{t-1} and S_t are storages at the beginning and end of the month t
Q_t is the spill volume in month t
A_t is the reservoir surface area in month t
e_t is the reservoir evaporation in month t
Y releases/yield/withdrawal respectively for the month t

55. The monthly withdrawal rate and the demand factors have been calculated based on the water requirement of the proposed cropping pattern at 120% intensity. Details are given in Annexure A.

3.7.1 Criteria for Reservoir Operation

56. The following criteria have been adopted for reservoir operation:

- Under the initial condition the reservoir has been considered to be at maximum conservation level at the start of the operation studies. The operation study is based on monthly time steps.
- The water is supplied continuously based on the cropping pattern and its monthly demand. Evaporation is also considered continuous throughout the operation period.
- The reservoir operation is carried out corresponding to data from the year 2002 to 2009 with consideration of rising sedimentation levels resulting in reservoir capacity depletion.

3.7.2 Water Requirement

57. The monthly irrigation water requirements (IWR) for the crops included in the proposed cropping pattern have been derived by applying the crop coefficients Kc approach for the different growth stages to the peak daily reference evapotranspiration ET_o. The crop coefficients Kc are based on the values quoted in FAO Publications 24 and 33 modified to reflect midseason and staggered planting and harvesting. The summary of gross irrigation requirement in hectare-meter for Siri Toi Dam is shown in Table-7.

Table 8- Monthly Irrigation Requirement for Siri Toi Dam

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
51	58	41	294	601	623	455	259	143	118	231	156

58. The details of the procedure and working of monthly crop water requirement are covered in Section 5 of this report.

3.7.3 Reservoir Evaporation

59. The monthly evaporation values as given in Table-2 are used in the reservoir operation study. The pan coefficient that is generally used to determine lake evaporation is around 0.7 on annual basis. However this value is used as 0.8 for monthly basis for reservoir operation studies.

3.7.4 Elevation-Area-Capacity Curve

The Elevation-Area-Capacity (EAC) curve has been obtained from the topographical survey of the reservoir area. The location map showing two alternate dam axis and the EAC curves for chosen axis are shown below as **Error! Reference source ot found.**.

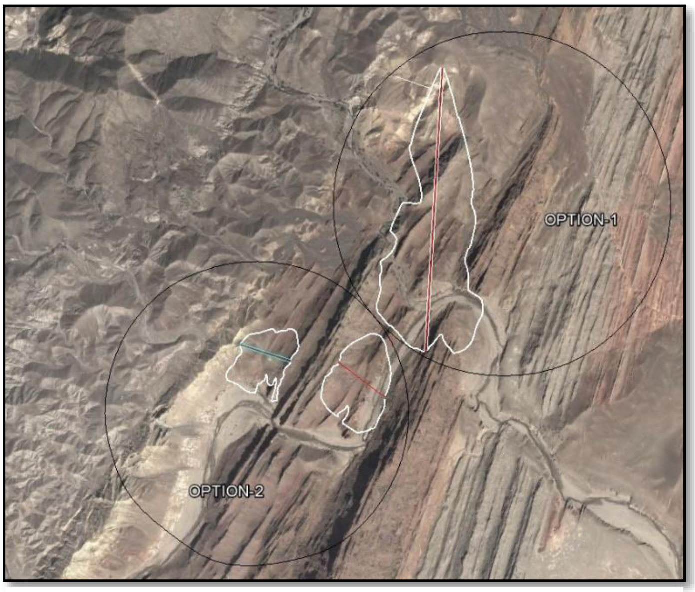


Figure 7 - Dam Axes Locations

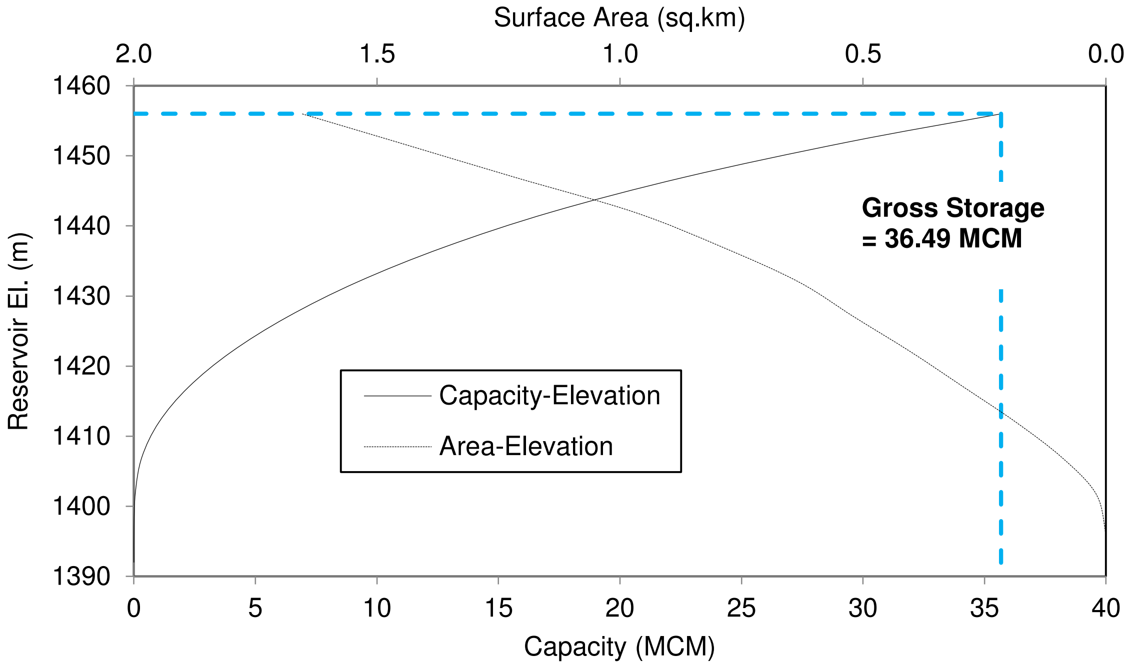


Figure 8 - Elevation-Area-Capacity (EAC) curve for Siri Toi Dam

3.7.5 Results of Reservoir Operation Studies

60. The simulation of reservoir operation is carried out for 35 years (1980-2014) based on rainfall, evaporation losses, inflow, gradually increasing reservoir sedimentation deposition. The operation is carries out for 35 years and not for the design life because of the limited data available. As no flow gage data was available for Siri Toi, the inflow data used in the reservoir study has been simulated on the ArcSwat Model for the Siri Toi dam location. The operation from 1980-2014 represented shortages of 18 % against the gross irrigation requirements of a design command area of 4027 hectares and a cropping intensity of 120% which lies within the acceptable range. The reliability of irrigation supplies for this period is 82% with consideration of reservoir siltation. The dead storage depletion will initiate from the first year of operation and will result in complete accumulation of sediments after 14 years. After this period the reservoir live storage will start depleting that will ultimately impact the design command area. The total life of the project is estimated as 80 years. The results for the 35 years operation for the other dam axis (option-1) is discussed in Section 7.1.3. The complete analysis for 35 years of reservoir operation is attached. For representation purpose only, the results of 2002-2009 are shown below:

Table 9 - Reservoir Operation Summary

Shortages Calculated for 4832.3 Ha (CI=120%, CA=4027 hectares)

Month / Year	2002	2003	2004	2005	2006	2007	2008	2009
Apr	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
May	0.00	0.00	2.26	0.00	0.00	0.00	0.00	0.00
Jun	0.00	0.00	6.17	0.00	0.00	0.00	0.00	0.00
Jul	0.00	0.00	4.53	0.00	0.00	0.00	0.00	0.00
Aug	0.00	0.00	2.60	0.00	0.00	0.00	0.00	0.00
Sep	0.00	0.00	1.43	0.00	0.00	0.00	0.00	0.00
Oct	0.00	0.00	1.17	0.00	0.00	0.00	0.00	0.00
Nov	0.00	0.00	2.29	0.00	0.00	0.00	0.00	0.00
Dec	0.00	0.00	0.18	0.00	0.00	0.00	0.00	0.00
Jan	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Feb	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mar	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total Shortage In Period of (2002-2009) years =						21	MCM	
				Total Demand (2002-2009) =		243	MCM	
				Shortages in terms of Total demand (2002-2009) =		8.5%		

61. The shortage in the year 2004 is observed because of the extreme drought conditions during that period. The inflow in this year was only 3,682 acre-ft (4.54 MCM).

3.8 Reservoir Sedimentation

62. The reservoir sedimentation is based on the annual sediment inflow also known as the long term sediment inflow, trap efficiency of reservoir, the ultimate specific weight of the sediment and the distribution of sediment within the reservoir. The life of the dam has been estimated as approximately 80 years with proper watershed management. However, due to the progressive sedimentation of the reservoir the command area will start reducing after the dead storage is completely filled. The following sections briefly elaborate the different parameters affecting the reservoir sedimentation.

3.8.1 Rate of Sedimentation

63. No sediment record for the specific site of Siri Toi is available. Sediment estimates are made to establish the dead storage capacity of the dam reservoir during the design period. In order to estimate sediment yield, the sediment data observed at Sharik Weir located on a right tributary of Zhob River has been utilized to estimate the sediment yield of Siri Toi catchment. Sharik Weir is the closest location near the Siri Toi site for which sediment data is available.

64. The regression equation plotted between Water Yield (Q) and Sediment Load (SY) for the available observed data is given below:

$$SY = -0.37864 + 7.93 \times 10^{-5} Q$$

Where,
SY = Sediment Yield in MST; Million Short Tons
Q = Discharge in Acre ft.

65. Based on the above equation the average annual sediment load has been computed as 0.901 Million Short Tons (MST).

66. The bed load has been computed based on the recommendation of US Bureau of Reclamation. It ranges from 2% to 15% based on the incoming sediment concentration. Taking 10% as the representative value the annual bed load has been computed as 0.1 MST. Therefore, the total suspended load which include the suspended sediments and the bed load are computed to as 1.00 MST.

Trap Efficiency

67. The trap efficiency of any reservoir is dependent on two parameters; inflow and reservoir capacity. Larger reservoirs, with respect to inflow volume, tend to accumulate more sediment as they provide more settling time for fine particles as compared to smaller reservoir. Using the inflow capacity relationship Gunnar Brune developed envelope curves for reservoirs to estimate the amount of trapped sediments.

Reservoir Depletion Rate

68. The specific weight of the sediments is mainly dependent upon the particle size and structure of the sediments, manner in which the reservoir is to be operated, change due to consolidation and shape of the reservoir. Since no data for the characteristics of the Siri Toi sediments is available, the probable composition and characteristics are inferred from the nearest sediments of Zhob River. The composition of the sediment load of Zhob River is 4.4% Sand, 68.5% Clay and 27.1% silt. The bulk density of the sediment based on the composition of sand, silt and clay is estimated by Lara and Pemberton (1963) method as:

$$\rho_{bulk} = \rho_{sand}\ p_{sand} + \rho_{silt}\ p_{silt} + \rho_{clay}\ p_{clay}$$

Where,
ρ = the density of sand, silt and clay respectively which is dependent on consolidation and the type of the reservoir.
p = percentages of sand, silt and clay respectively of the incoming sediment

69. As sediment trap in the reservoir, compaction causes the deposited sediment density to increase; the increasing unit weight of the sediments is expressed by Miller's Equation as given below.

$$\rho_{bulk} = \rho_{intial} + 0.4343\ K[\{T/\ (T-1)\}\ \ln(T)-1]$$

Where:
ρ_{bulk} = density after T years of compaction
ρ_{intial} = Initial density and
K = the constant dependent upon reservoir and the grain size composition of the sediments.

70. From the Miller (1953) equation the sediment densities for 10, 20, 30 and 40 years have been computed as 979.02, 1011.93, 1032.13 and 1046.78 kg/ cu.m respectively. The dead storage capacity that will deplete in the early 14 years is computed as 6.49 MCM (5,216 acre-ft).

71. The gross, dead and live storage capacity of the dam is as follows.

Gross Storage	Ungated	36.49 MCM (29,579 acre-feet)
Dead Storage		6.49 MCM (5,261 Acre feet)
Live Storage	Ungated	30 MCM (24,318 Acre feet)

Total Depletion of Dead Storage	14 Years
Life of the Dam	80 Years

72. As the capacity inflow ratio for the dam is large i.e. 36.49 MCM / 39.79 MCM= 0.917 sluicing or flood flushing is not possible due to unavailability of excess water as suggested by ICOLD Bulletin Sedimentation and sustainable use of reservoirs and river systems (2009). However, check dams and other watershed management practices are planned to minimize the sediment yield and maximize the life of the reservoir.

4 SOIL AND WATER QUALITY

4.1 Introduction

73. The catchment area of the Siri Toi dam is about 960.5 sq.km. Major area of about 831 km2 (87 %) is occupied by mountainous terrain. The minor extent of plain area occurs mostly along the sides of Zhob River and is about 124 km^2 (13%), and the soils are generally loamy to clayey with some parts of soils that are gravelly loamy or sandy. This area bears high agricultural potential under irrigation in this basin. In lower reaches, most soils are clayey. The mountainous part is the main site for natural vegetation.

74. The climate is semi-arid sub-tropical continental high lands and manifests itself in great diurnal and seasonal / variation in temperature, where evaporation is high. Therefore rain water should not be wasted. Water rushes down the steep slopes, which needs to be captured and usefully utilized in the broad valleys for biomass production, at the same time checking soil erosion and saving the top soil resources.

75. Optimum utilization of every drop of water is becoming increasingly important with the ever increasing population to meet their food requirements. Knowledge of soils suitability for irrigation in any water development project is a pre-requisite. High cost of such projects necessitates the evaluation of soil qualities for crop production. More efficient use of land and water is the key to the success of such a project.

4.2 Methodology

76. To meet the objectives, a reconnaissance visit of the area was conducted to familiarize with the land forms, parent material, topography, type of soils and land use. Soil and water samples were taken in the field. A semi detailed soil survey was conducted as per requirement of FAO frame work for land evaluation, the survey included.

- Recognition of the land form.
- Identification of soils in the command area.
- Selection of traverses across the drainage pattern.
- Digging and description of pits for collection of pattern soil samples.

77. The secondary data was collected from the Agricultural District officer and Agricultural Research Institute, Quetta. The soil classification, land form, land use and land capabilities were described according to the soil survey manual and FAO guidelines. Soil and water samples were analyzed in the laboratory to observe the physio-chemical characteristics of soils present in the command area. In view of analytical results, project soils were described with respect to fertility status, textural classification, salinity, alkalinity, gypsum requirement and the mitigation measures.

4.2.1 Soil Genesis and Land Form

78. The characteristics of soils are the result of the action of climate and vegetation upon the parent material over a period of time as conditioned by the relief. Cultural environment created by man's use of the land considerably modifies the off sets. Vegetation plays an important role in the soil development. Plants initiate soil homogenization through the activities of roots. The remains of decayed plants and roots not only provide organic matter that enriches and stabilizes the soils, but also serves as food for soil animals and micro-organisms and are

thus directly responsible for their activities. The distribution and density of vegetation species are mainly controlled by the availability of moisture and extent to which it is conserved.

79. The land forms of the project area comprise of piedmont alluvium deposits derived from surrounding hills and laid down by the River / River and other adjacent torrents. The courser material like sand and gravel / stones settle down near the River side, where as the finer material gets washed away to the core of the plain. The surface relief is uneven to nearly level with slope from South West to North East. The soils are recent to sub recent age.

80. The characteristic of piedmont plain varies, depending upon the parent material, surface configuration and age of soils. The texture ranges from loamy sand to clay loam. The torrent beds are gently sloping deposits of stones, boulders and gravels laid and rounded by running water. The distance from the source grades the size of the boulders and stones. The material deposits near the source are bigger where as those far from the source are of smaller size.

4.2.2 Nature of Soil and Classification

81. Parent materials play an important role in determining soil characteristics due to different rate of weathering, chemical and physical properties. Soil thickness, texture, content of coarse and fine fragments, calcareousness, mineralogy and to some extents color are closely related to parent materials. Climate (precipitation and temperature) generate the shape and characteristics of the soils due to accumulation of the $CaCO_3$ in low rainfall area, leaching in humid area, erosion of soils on the sloping area and deposition of material down the slopes. Organic matter accumulation, profile mixing, nutrient cycling, structural stability are the activities of living organisms. Topography may hasten or delay the work of climatic forces and time needed for profile development.

82. The rocks of the project area are consolidated sedimentary, limestone and sandstone. The sedimentary rocks are classified as conglomerates, containing more or less rounded stones to boulders with a large portion of sand filling in the interstices. The parent material piedmont alluvium soils is derived from sandstones and limestone of the surrounding hills. These soils are well to excessively drained and calcareous. The soils near the mountains have gravels of varying size of coarse texture depending upon the length of time period. The sub recent soil is weak structured, well drained, calcareous and homogenized up to moderate depth. The old piedmont plains soils, occupying gently sloping and nearly level position, are moderately deep to deep, moderately structured and are homogenized up to considerable depth.

4.2.3 Soil Classification

83. The soil of the project area alluvium material i.e. piedmont alluvium. The piedmont alluvium is nearly level to gently sloping. The top soil is dark brown, moist, silt loam to silty clay loam, slightly sticky, slightly plastic, friable, slightly hard, fine tubular pores, few scattered gravels, and has a clear smooth boundary.

84. The subsurface soil is dark brown to reddish brown in color texture, and has a weak sub angular block structure, sticky, plastic, friable, slightly hard, fine tubular pores, few fine roots, and a clear smooth boundary. The piedmont alluvium is used for limited general cropping, under irrigation and dry farming condition.

85. Erosion and traditional management are two main problems. This unit has high potential for irrigated cultivation with sufficient irrigation water and modern management, including adequate use of fertilizers and structures for safe disposal of run off, crop yield from this could be increased considerably. Emphasis should be on cultivation of high value crops like vegetables, orchards etc.

4.2.4 Present Land Use

86. The command area of the project falls in semi-arid climatic zone. Flash flood inundation also takes place along the River fields where flash flood water accumulates, some natural vegetation crops up and few tree groves come up. This biomass helps to sustain livestock and provides fire wood. At present, agriculture doesn't exist in the project area.

4.2.5 Land Capability

87. The term land capability classification refers to the assessment of the potential or ability of a tract of land to sustain production of common farm crops or for forestry or range development. It is a method of land evaluation for year round conditions that takes into account only the general or common agricultural use of land under existing conditions and available resources. The land capability classification is differentiated on the basis of degree or severity of any limitation associated with the land affecting its use for general farming.

88. The project command area lies under the land capability class "Moderate Agricultural land". This land capability class includes land that has limitation, erosion and relief which may act individually or collectively, becoming moderately sever in nature to affect the cultivation or growth of most farm crops so that their yields are subsequently reduced. The limitation either cannot be done away through any practical means or require higher investments to achieve improvement. Their adverse effects can be partly offset through special management of soils, water and fertilizer and selection of appropriate crops. The choice of crops that can be grown successfully becomes narrow.

89. Soil erosion and topographic features are main limitation in the present Barani conditions. The other limitations are tilth and stony / gravely condition in soil texture. The recommended measures are construction of high and wide field bunds, stabilizing of bunds by grasses and trees, continuous cropping, provision of the right of way to the surface water, ploughing and cropping against the flow pattern and provision of lined structures to control the gullies.

4.2.6 Crop Suitability

90. Crop suitability rating is the suitability of a certain crop on specific soils for the most favorable season of the year having adequate availability of moisture. It is a soil-crop-climate irrigation interface which is reflected by its classes, the most suitable to not suitable. It is the set of characteristics of the soil physical and chemical properties as well as nutritional status of soil or its response to applications of fertilizers compared with crop agronomic requirements under the climatic conditions of the area. Judicious availability of irrigation water has been considered to be a prerequisite for assessing suitability of all crops in the project command area.

91. For the project command area, wheat, vegetables, pulses and orchard are the well suited crops. For these crops, the land has no major limitation that will reduce productivity or cost / benefit ratio even under traditional management. The crop may grow well and produce good yields. For these crops, the soils have favorable physical, chemical and drainage

characteristics moderate or high fertility level and are responsive to good management. Under good management; the crop could produce high yields. See Table 1.1 for crop suitability.

Table 10 - Crop suitability

Sub-project (soil)	Suitable Crops							
	Onion	Lady finger	Cucumber	Tomato	Pulses	Wheat	Orchard	Rabi Vegetables
Siri Toi (St1)	2	1	1	1	1	1	2	1
(St2)	2	1	1	1	1	1	2	1

4.3 Physio-Chemical Characteristics

4.3.1 Particle Size Distribution and Textural Class

92. Hydrometer method was used in the laboratory for particle-size distribution. According to the analytical result the projects soils are classified as moderately fine textured soils i.e. clay loam and silty clay loam and fine textured at some places i.e. silty clay and clay. Soils at the site are moderately fine textured ranging from clay loam up to 18" depth to silty clay loam at the lowest 36// depth. The clay contents varied from 27.6 to 35.6 percent and sand from 17.2 to 37.2 percent respectively. The clay content varied from 31.6 to 42.4 percent while silt and sand content varied from 29.2 to 33.2 and 28.4 to 39.2 percent, respectively.

93. Fine textured soils have high water holding capacity but the available water may be low as water and nutrients are held so tightly that these become un-available for plant growth. Clays are also quite susceptible to crusting and give rise to poor seedling emergence. Table 10 shows the particle size distribution and textural class(s) of the project command area.

Table 11 - Particle Size Distribution and Textural Classification of the soils in Project Command Area

No.	Sample ID	Depth	Clay %	Silt %	Sand %	Textural Class
1.	Siri Toi	18–22cm	27.6	37.2	35.2	Gravely Clay Loam
2.	- do -	28–70cm	29.6	33.2	37.2	Clay Loam

4.3.2 Fertility Status of the Project Soils

94. With respect to soil fertility of the area, the organic contents are significant source of plant nutrients. It has also favorable effect upon the physical properties of soils. The presence of organic matter in the soil of an area should be more than 0.86 percent. The organic matter in the project soil ranged from 0.60 to 1.24 percent. At Siri Toi site in the project command area, the organic matter position is marginal. The phosphorous content ranged from 2.0 to 5.2 mg/kg being marginal, while deficient at all other sites.

95. The Potash content varied from 116 to 220 mg/kg being adequate at all sites. For maintaining soil health and enhancing nutrients status of the soils, it is suggested that farm yard manure, green manure and incorporation of crop residues should be done in addition to application of recommended doses of mineral fertilizer. Tables 11 & 12 show the recommended fertilizer quantity for major crops.

Table 12 - Fertility Status of Soils

No.	Sample –ID	Depth	O. M. %	N (mg/kg)	P (mg/kg)	K (mg/kg)
1	Siri Toi	18–22cm	1.24	0.062	5.2	220
2	do -	28–70cm	1.12	0.056	4.5	178

O. M. Organic Matter

4.3.3 Salinity / Alkalinity Status of the Project Command Area

96. According to the analytical results of soil samples (Table 1.3), the sodium adsorption Ratio (SAR) and Exchangeable sodium percentage (ESP) were calculated. The SAR ranged from 6.24 to 13.20 while ESP ranged from 7.36 to 15.40. Based on standard criteria for salinity, the surface soils of Siri Toi are normal, while the sub soils of these sites are non-saline Soda.

Table 13 - Sodium Adsorption Ratio, Exchangeable sodium Percentage and Salinity / Sodicity Category

No.	Sample ID	Depth	SAR	ESP	Salinity / Sodicity Class
1.	Siri Toi	18–22cm	10.10	12.00	Normal
2.	- do -	28–70cm	6.24	7.36	Normal

4.3.4 Lime contents, Saturation Percentage and Gypsum Requirements

97. The lime contents, calcium carbonates are enough and strongly calcareous at the sites of Siri Toi. The upper soil is strongly calcareous, while at lower depth the soil is slightly calcareous. The saturation ranged from 40.69 to 48.46 percent in Siri Toi soils, where as it is 46.51 to 52.40 percent. The saturation percentage is directly related to clay contents. The gypsum requirement has been calculated according to the salinity/alkalinity status need. It varied from nil to 3.44 tons per hectare. The highest amount of about 3.5 tons is required for subsoil of sites. SAR = Sodium Adsorption Ratio

ESP = Exchange Sodium Percentage

4.3.5 Other Chemical Characteristics

98. The laboratory results of soil tests given in Table 1.4 show that the command area soils are neutral to slightly alkaline in nature. The pH varied from 8.2 to 8.5. The soils at Siri Toi are neutral, the pH ranging from 7.5 to 8.0. The electrical conductivity is 1.00 ds/m at all depths of Siri Toi site. All the samples are non-saline and do not have any problem of salinity. The soluble cations and anions are also within safe limits. The Ca+ Mg ranged from 2.10 to 6.90 mg/L and bicarbonates and chlorides are in the range of 1.60 to 3.52 and 1.28 to 4.56 mg/L respectively. The exchangeable sodium ranged from 6.40 to 24.18 mmol/100gram.

Table 14 - Other chemical characteristic of the project soils

No.	Sample ID	Depth	pH	ECe dS/m	(Ca+Mg)	HCO_3	Cl	Na
					mg/L			$Mmol_c$/100gm
1.	Siri Toi	18–22cm	7.5	1.09	3.50	2.50	3.40	12.37
2.	- do -	28–70cm	8.0	1.08	2.10	2.40	3.60	6.40

4.3.6 Irrigation Water Quality

99. The ground water depth in the project command area is 37 m to 46 m as the command area lies along the River. The water samples were collected during field survey and analyzed in the laboratory for Irrigation water quality purposes. The analysis results given in Table 1.5 reveal that the soluble salts are within safe limits and electrical conductivity 850 ds/m is within the permissible limit. The sodium adsorption ratio is 2.45 meq/L. The water is categorized as C1S1 i.e. low saline and low sodium. The available water holding capacity is ranged from 12 to 15 cm per meter. This water is fit for irrigation purposes and could be used safely without any danger of salinity or sodicity encroachment.

Table 15 - Chemical Quality of Water

1.	Ca	2.85 me/L
2.	Mg	me/L
3.	Na	e/L
4.	pH	7.8
5.	K	0.09 me/L
6.	CO_3	Nil
7.	HCO_3	e/L
8.	Cl	3.60 me/L
9.	SO_4	7.63 me/L
10.	Total cation	7.80 me/L
11	Total anion	5.36 me/L
12.	EC (dSm^{-1})	1.8
13	Res Na_2CO_3 meq/L	Nil
14.	SAR	1.69 me/L

4.4 Soil Management Factors for Project Command Area

100. A sound system of management in agricultural production should ensure that the land, at least be as productive at the end of a production cycle as it was at the beginning. This necessitates that nutrients content of the soil is sustained; drainage and infiltration are not impaired, weeds growth is under control and the soil is neither blow nor washed away. The factors involved in sound management are dependent upon the physical and chemical characteristics of soils. The major factors required for project command area development are soil conservation, fertility, physical properties and tillage.

4.4.1 Soil Erosion and Conservation

101. Sheet and gully erosion are serious hazards in the command area. Sheet erosion removes soil material in thin layers and causes serious damage to cultivated lands. In some instances soil material to ploughed depth is washed away in a single rainy season. The bare soil, lack of vegetative cover and relief are main factors accelerating the erosion. The runoff from sloping lands grows into a sizeable discharge and causes rills on the land surface, which ultimately develop into deep gullies. The gullies encroach upon adjacent land and ramify in a complex pattern.

102. Remedial measures for control of soil erosion are change in cropping system, contour tillage, terracing, water ways, vegetation and gullies plugging. Good cropping system should not only mention productivity, but also cover the field particularly in rainy season. In crop rotation, dense growing crops should be grown like sorghum along with potatoes and maize etc. Tillage operations and cultivation of crops on contour is less expensive and most effective method of checking erosion and run off. Terracing of slope is common in the area, but the terrace is not designed, located and maintained properly. Proper design and maintaining of water ways from higher fields to lower are necessary to carry the run off during heavy rains. Vegetation on the bank of the fields and other cultivated areas will definitely minimize the erosion. For control of gully erosion, the construction of drop structures is important to slow down the run off to non-erosive velocity.

4.4.2 Maintaining Soil Fertility

103. A fertile soil must supply, in reasonable amount and in suitable balance all the nutrients, which a plant takes in from the soil. Continuous crop production and leaching by rains are a great loss. A sound system of management ensures preservation of suitable organic matter content in the soil for production of high yields of crops. For maintenance and increase of the organic matter, return as much plant residues to soil as are possible, stop the grazing of fallow fields, plough the harvested crops, green manure and control water erosion. These practices should be encouraged at all levels to maintain the humus contents of the soils. Due to traditional farming, the farmers use only nitrogenous fertilizer on small scale. They do not appreciate application of adequate quantities of balanced fertilizers for boosting production. Therefore the popularization of fertilizers is a must through demonstration plots in the area.

4.4.3 Physical Properties and Tillage

104. A productive soil should have favorable physical properties in addition to being fertile. Physical properties such as texture, porosity and permeability influences crop suitability and management requirements of the soils. The soils is contradictory to clay soils. Addition of organic matter regularly to the soil produces well granular top soils that are easily workable and stable in the wet form. Beside, soils conservation measures manuring of soil and proper tillage operations including tilling of soil during fallow period will positively improve the physical properties of the soil and ultimately the agricultural production. After irrigation water supply in the area the land can be remedied into good tilth by land leveling, green manuring, continuous cropping and modern tillage practices with passage of time.

4.4.4 Socio-Economic factors

105. A potentially fertile soil in favorable environment will only ensure high crop yields. The potential of the land can only be realized if it is farmed by men with necessary energy, skill and resources to manage best use of it.

5 AGRICULTURE

5.1 Introduction

106. Siri Toi Dam is an irrigation project where about 4027 hectares of culturable land will be brought under irrigated agriculture. It has been estimated that 3026 hectare-meter of water will be available annually for developing agriculture in the command area of the Dam on the both Right and Left banks of the River. As in present condition the agriculture is not exist but after commissioning of the project, perennial irrigation supply would be available for the cropping intensity to 120 percent. There will be an appreciable socio-economic development as a result of the project. However, without project the existing agriculture situation will remain unchanged. The assessment of current agricultural production and the future agriculture development with project conditions is detailed in the subsequent sections.

5.2 Approach for Assessment

107. For the purpose of project, planning studies and evaluation of incremental production is carried out by the project economist to examine, whether project would generate agriculture production to justify project construction and O&M cost. For estimation of incremental production, three conditions of agriculture have been studied namely:

- Present Agriculture Situation
- Agricultural Development "Without" project
- Agricultural Development "With" project

5.3 Present Agriculture

108. The project area is not cultivated with reasonable cropping pattern as no agriculture farm/cultivated land was found during comprehensive agronomic survey. The local community is much willing to agricultural development. The future agricultural development status of the area was briefly discussed with the land owners and farmers.

5.3.1 Data Sources

109. To accomplish agricultural studies, the following secondary and primary data sources were utilized:

- Agricultural statistics of Balochistan 2014-15.
- Agricultural Co-operative Department Balochistan.
- Executive District office, Agriculture.
- Agro-Meteorological Bulletin of Pakistan.
- Agricultural Research Institute, Quetta.
- Agronomic field survey of the project area including interviews with the land owners and farmers of the command area.

5.3.2 Agronomic Field Survey

110. Location/site specific information is essential to supplement the broad based published data. Therefore, for gathering primary project data on existing agriculture, a well-designed

questionnaire addressing farmers was prepared. The subject of questionnaire included land use, cropping pattern, crop yield, crop inputs and cultural practices in the project area. Selective farmers were contacted and interviewed. Group discussions with farmers were also conducted to verify level of yield, inputs and cultural practices. Data collected from farmers showed repetition and uniformity. Some additional primary data was also collected; reconfirmation of certain facts and figures was made through personal communication and discussion with agricultural specialists of the district. The information so collected, was found useful in the evaluation of status of past agricultural practices.

5.3.3 Farm Size

111. The farm size has a major impact on the agriculture development of an area, because large farms have comparatively higher absorption capacity for development as compared to smaller farms. The farm size and their distribution in the command area are key factors to evolve a practicable strategy which suits the socio-economic condition of the farming community of the area.

112. The average size of farms in the proposed command area is 3.5 hectares. According to the distribution by size, majority of the farms are in between 2.5 hectares to 4.5 hectares. However, 5 to 10 percent farms are either below 2.5 hectare or above 4.5 hectare. In general it may be concluded that the farm size are reasonable as compared to other parts of the province, especially northern parts, where the farm size is generally less than 2.0 hectares.

5.3.4 Land Tenure

113. Land tenure system in Pakistan is categorized as owner-operated, owner-cum-tenant and tenant. The majority of the farms in project area are owner operated. The high percentage of owner operated farms would be conducive for the rapid acceleration and development of the area. Since owner operated farms have a greater ability and willingness to make both short and long term investment towards farm improvement. This is because the owner of operated farm receives the entire incremental income. Tenant farmers have little or no incentive to make long term planning or investment due to uncertainty of their future. The tenant farmers carry out only annual or limited improvements, as major share of the increased production in usually received by the land owner. The land tenure of the project area is that the majority of the farms are owner operated, while very small percentage is owner cum-tenant. The only tenant managed farms do not exist.

5.3.5 Water Rights

114. During field visit it was observed that the command area is located on both sides of River. Therefore, irrigation channel is proposed on both sides of Dam for irrigating the command area (proposed CCA=4027 ha) on both banks. The water right of both side command area are equal and there is no confliction regarding water rights.

5.4 Existing Cropping Pattern & Intensities

115. The cropping pattern and intensities of an area are indicators of its agricultural development level. The main source of information about the cropping pattern and intensities is agronomic field survey. Presently agriculture doesn’t exist in the project area.

5.5 Present Crop Yields & Production

116. Agriculture is not being practiced in the project area as there is no irrigation structure in functioning as per agronomic field survey and consultation with community.

5.6 Agricultural Development "Without" Project

117. At present agriculture doesn't exist in the area. While the command area is good enough for agricultural production but the irrigation system has been damaged since long.

5.7 Future Agricultural Development "With" Project

118. The provision of irrigation water will bring the land under cultivation, subsistence level farming in the command area to sustainable productive agriculture. This will also bring socio-economic changes and prosperity in the area. The allocation of volume of water for irrigation and the resultant progress in the cropping pattern, intensities and productivity in command area have been worked out and described in the following Table 16.

Table 16 - Proposed cropping pattern, cropped area and intensities

Crop		Kh – Veg	Pulse	Apple / Apricot	Wheat	Garlic	Rabi - Veg	Total
Without Project	Area (ha)	0	0	0	0	0	0	0
	Cropping intensities (%)	0	0	0	0	0	0	0
	Yield (Kg/ha)	0	0	0	0	0	0	
	Production (Tons)	0.00	0.00	0.00	0.00	0.00	0.00	
With Project	Area (ha)	805	806	805	966	644	806	4,832
	Cropping intensities (%)	20	20	20	24	16	20	120
	Yield (Kg/ha)	18500	1105	13500	3650	9,500	17800	
	Production (Tons)	14893	891	10868	3526	6118	14347	

5.8 Future Cropping Pattern & Intensities

119. With the provision of irrigation water, there will be improvement in cropping pattern and increase in cropping intensities of the currently un-irrigated area. The cropping pattern and intensities are proportionate to the water availability in the command area. According to the hydrological studies, about 3026 hectare-meter of water will be available for irrigation, after the construction of the proposed Siri Toi Dam project. Keeping in view the water availability, crop water requirement, irrigation efficiency, agro-climate, soil crop suitability and socio-economic conditions in the project area, a suitable cropping pattern has been designed at cropping intensity of 120 percent. See details in Table 17.

Table 17 - Proposed cropping pattern, cropped area and intensities

S. No	Crops	Proposed Cropping Intensities (%)	Area (ha)
Rabi Season			
1	Wheat	24.00	966.00
2	Rabi Vegetable	20.00	806.00
Sub Total		**44.00**	**1,772.00**
Kharif Season			
3	Kh-vegetable	20.00	805.00
4	Pulses	20.00	806.00
5	Garlic	16.00	644.00
6	Apple/Apricot	20.00	805.00
Sub Total		76.00	3,060.00
Total		**120.00**	**4,832.00**

120. The total cropped area is 4,832 ha; the salient features of cropping intensity in Rabi season include wheat and vegetables. Wheat cropping intensity has been proposed up to 24 percent. Other crops have almost equal opportunities such as Rabi & Kharif vegetables, garlic, pulses and Orchards. All the crops are quite suitable in the area. The vegetables and orchards will be cash crops.

5.9 Gross Irrigation Requirement

121. To meet net consumptive use requirements of the crops at the root zone, provision for the losses of water on the way is made to determine the volume of water required at the Head Works. The gross irrigation requirement for the Project at source is computed as follows.

$$\text{Gross Irrigation Requirement} = \frac{\text{Net Crop Water Requirement}}{\text{Project Irrigation Efficiency}}$$

122. The gross irrigation requirements worked out with the related irrigation efficiency for the project area. The net and gross irrigation requirements of the project for monthly are summarized in Table 18. The maximum water required the month of August is 622 hectare-meter. This is due to high intensity of crops. The minimum requirements are from January to March.

Table 18 - Gross Irrigation Requirements

Conveyance efficiency 82% Field efficiency 80% Irrigation efficiency 65%								Command Area 4027 Hectare
Months	**Crops**	**Kh. veg**	**Pulses**	**Garlic**	**Wheat**	**Apple/ Apricot**	**Rab. veg**	**Total**
	%	20	20	16	24	20	20	120
	Area in Hectare	805	805	644	966	805	805	4,832
April		43	0	71	67	113	0	293
May		125	0	193	74	209	0	601
Jun		234	0	178	0	211	0	622
July		186	0	84	0	186	0	455
August		113	0	0	0	146	0	259
September		0	0	0	0	143	0	143
October		0	9	0	80	29	0	118
November		0	84	0	71	16	59	230
December		0	51	0	62	6	36	155
January		0	0	0	34	0	16	51
February		0	0	0	36	1	21	58
March		0	0	0	40	0	0	41
Annual Demand (Hectare-Meter)								3,026
Annual Demand (MCM)								30
Maximum Demand (Cumec)								2.37

5.10 Development of Intensities and Area Built Up

123. It is expected that the area development to achieve the ultimate intensities of 120 percent would be completed from 5 to 6 years after commencement of the project. The cropping pattern is quite similar to what is already grown in the neighborhood of the project area. It is expected that the local agricultural extension network would be reinforced to facilitate the transition from un-irrigated to irrigated agriculture technology.

5.11 Justification for Selection of Crops & Intensities

124. The cropping pattern will include food grains as the basic necessity and cash crops such as vegetables and orchard. The crops included in the proposed cropping pattern have been selected as, the agro-climate and soil conditions are favorable for the growth of these crops. The farmers are already familiar with these crops and the department of agriculture shall provide extension services for the introduction and cultivation of the proposed crops. Common orchards & vegetables in both the season will be grown, which are marketed and consumed in the surrounding area. The farmers are well familiar about the growing of common orchards & vegetables.

5.12 Projected Crop Yields and Production

125. The yield projection for the project area has been made keeping in view the current scenario, findings of the agronomic field survey in and around the project area. Discussions with the local agricultural officer were held and the crop production literature of the department of Agriculture and Research Institute was consulted. The adopted yields are within the limits of the farmers capacity and easily achievable. Technical and agricultural factors affecting annual growth rate and yield development have been considered while projecting the yields. The projected crop yields under "with" project conditions and production are given in Table 19. The yield projections are based on the following basic information and assumptions:

- The findings of soil studies of the project command area, the project soil production potential for the proposed crops and the required area available for the projected intensities.
- Adequate and regular irrigation water supplies would be available to meet the crop water requirement in full.
- Agro-climatic conditions are suitable for successful growth and achieving potential yields.
- Crop production technology and required inputs will be available in the area.
- The network of agricultural extension services would be strong enough for transfer of technology and making the inputs timely available to the farmers.

126. Experience from other projects in the nearby areas indicates that the ultimate yields are reasonable and can be achieved in the area. In view of agriculture development policies, the proposed yield would be achieved in a period of three years after the commencement of the project, except orchards the fruit bearing of which will start after five years, for project crop yield and production Table 19.

Table 19 - Projected Crop Yields and Production

No.	Crops	Projected Crop Yield & Production		
		Area (ha)	**kg/ha**	**Production (Tons)**
1	Wheat	966.00	3650	3526
2	Rabi Vegetable	806.00	17,800	14329
3	Kh-vegetable	805.00	18,500	14893
4	Pulses	806.00	1105	891
5	Garlic	644.00	9,500	6128
6	Apple/Apricot	805.00	13,500	10868

5.13 Agricultural Inputs

127. The use of recommended rates of farm inputs is essential to achieve the targeted yields. At present, the rate of inputs adopted for the project area are not proportionate to the projected yields. The inputs required for the projected yield in future, are seed, fertilizer, tillage process, labor and plant protection measures.

128. Disease free seed of improved variety is necessary to achieve optimum production. The use of recommended seed rates is also very important to establish, the desired plant population in the field. The department of Agriculture should therefore, ensure the uses of recommended seed rates of good variety for increased production.

129. Chemical fertilizer is the most effective input to increase crop yields and production. Its application at the right time and with the optimum combination of required nutrients is essential to obtain targeted production. To maintain the proper percentage of organic matter in the soil, farmyard manure, especially for vegetables and orchards is necessary. It provides micronutrient, which are lacking in the commercially available fertilizer. Farm-yard manure also improves carbon nitrogen ratio in the soil and enhances the water holding capacity of the soil. The recommended rate of fertilizer for project area crops are given in the soil studies chapter. The rates of nutrients were fixed proportionate to the projected yield level.

130. Plant protection measures are essential to save the crop from the insects and pests, particularly those crops which are easily susceptible to these, like vegetables and orchards. The provision of adequate and timely sprays is necessary for achieving targeted production. With the increased use of fertilizer, the crops are likely to become successful and more resistant to insects and pests. Cultural practices like crop rotation, adjustment of sowing time, use of healthy seed crop varieties can go a long way in minimizing the crop losses from the insects/pests and diseases, the number of ploughing and planking for preparatory tillage and seed bed preparation should be followed according to the modern Agricultural practices as identified by the agricultural scientists. The agricultural extension services should be provided for optimum crop production in the project area. Proper tillage operation will improve the physical properties of the soil like texture, structure, porosity, and water holding capacity and ultimately the crop yield.

5.14 Factors Affecting Growth of Agriculture

131. Every project for development of agriculture depends upon the following factors for development of agriculture sector. If these conditions are not properly given attention then there are chances of failure, and it is designated as project running "without the conditions" required for the enhancement of agriculture. These factors are:

- Management Factor
- Means of Communication
- Allocation of Fund

5.14.1 Management Factor

138 In agriculture, Balochistan and its regions being mainly involved in subsistence farming cannot produce sufficient food items to meet its demands due to inadequate irrigation & water management system. A number of important surface irrigation schemes have been damaged. In addition many structures for control of flash floods have been Damaged or destroyed. The present irrigation is being done with Tube wells which cause groundwater depletion. In future, if proper attention is not given for betterment in irrigation system according to the crop requirement, improvement of On-Farm Water Management will increase in water supplies otherwise, condition will lead to further deterioration or remain as such in the future without any project conditions.

5.14.2 Means of Communication

132. Physical access to markets by both traders and consumers is Zhob-Dera Ismail Khan Road and Zhob-Quetta Road. A majority of traders were also confronted with higher procurement prices and transport costs leading to lower profit margins and sales volumes. These roads are in fair condition, and transport charges to Quetta or DIK can be as high as Rs. 120-150 per 100 Kg.

5.14.3 Allocation of Funds

133. For future improvement of above factors, funds are required and can be generated under Agriculture Plan by approaching the concerned departments, Government of Balochistan.

6 GEOLOGY AND GEOTECHNICAL INVESTIGATIONS

6.1 General

134. Siri Toi dam site is located in the northern part of the Zhob River Basin. It is an isolated tributary of the Zhob River. This site is located in district Zhob, about (62 km.), to the north-east of Mir Ali khel. The main tributary of Zhob River near Kili Gul Khan. The latitude and longitude of the sub-project are 31° 35’ 58” Latitude, 69° 15’ 58” Longitude and the mean altitude of the command area is 1350 m above mean sea level. The proposed dam site and reservoir are located in a valley stream called Siri Toi River. The location of the proposed dam is shown in Figure 9.

6.2 Purpose

135. Main purpose of dam is to provide water to the adjoining area for irrigation and other household purposes. This chapter of report mainly comprises of geological survey and studies of surface geological mapping of dam site, reservoir and command area.

6.3 Accessibility

Access from Zhob to the dam site is via Zhob-Wana road. Initially in the direction of north-east for a distance of 42 Km then turning to Sambaza road in south-east direction up to Kili Hazrat Sahab by a link metaled road by travelling 10-Kms, followed by kaccha shingle/gravel track for a distance of another 10 Km up to the dam site. The journey takes about 2.25 hours from Zhob.

6.4 Topography

136. High ridges surround the dam area which lies at the foot of Masa Khwal, a prominent rock outcrop about 305 m high in the middle of the valley. The terrain is generally flat in the dam area and it is for command area development. It is located in an environment of degraded rangelands. The average altitude of the Siri Toi command area is 1350 m above mean sea level.

6.5 Drainage of the Area

137. The drainage of the area is showing dendritic drainage and parallel drainage pattern on the Dam area. In geomorphology, drainage systems are the patterns formed by the streams, rivers, and lakes in a particular drainage basin. They are governed by the topography of the land, whether a particular region is dominated by hard or soft rocks, and the gradient of the land. Geomorphologists and hydrologists often view streams as being part of drainage basins.

6.6 Previous Work and Available Data

138. The literature available for the Siri Toi dam site is “The Reconnaissance Geology of Part of West Pakistan” a geological map prepared by government of Canada for government of Pakistan under Colombo Plan on scale 1:253,440 (Map No 29, FORT SANDEMAN 39 A.E.) and a “Geological Map of Pakistan” prepared by Geological Survey of Pakistan in 1964 on scale 1:2,000,000. Both maps present a geological appraisal of the area.

6.7 Regional Geology and Tectonic Setup

6.7.1 Pishin Basin

139. The Pishin basin is a young sedimentary basin that has formed since early Tertiary times. It is located between Chaman transform fault in the west and Ghazaband fault in the east. Its extension is Katawaz and Makran convergence zones in its northern segments.

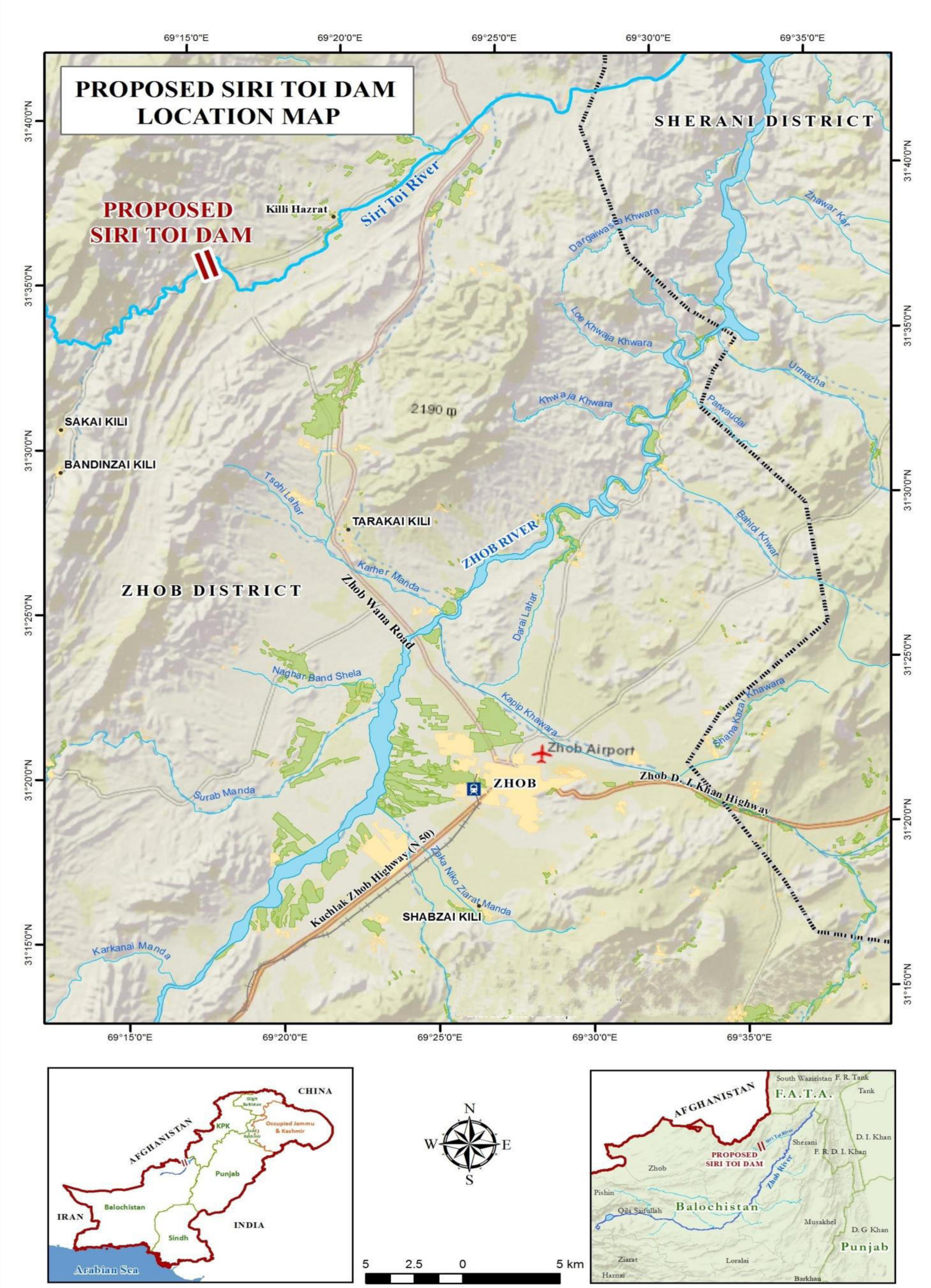


Figure 9 - Proposed Sri Toi Dam Location

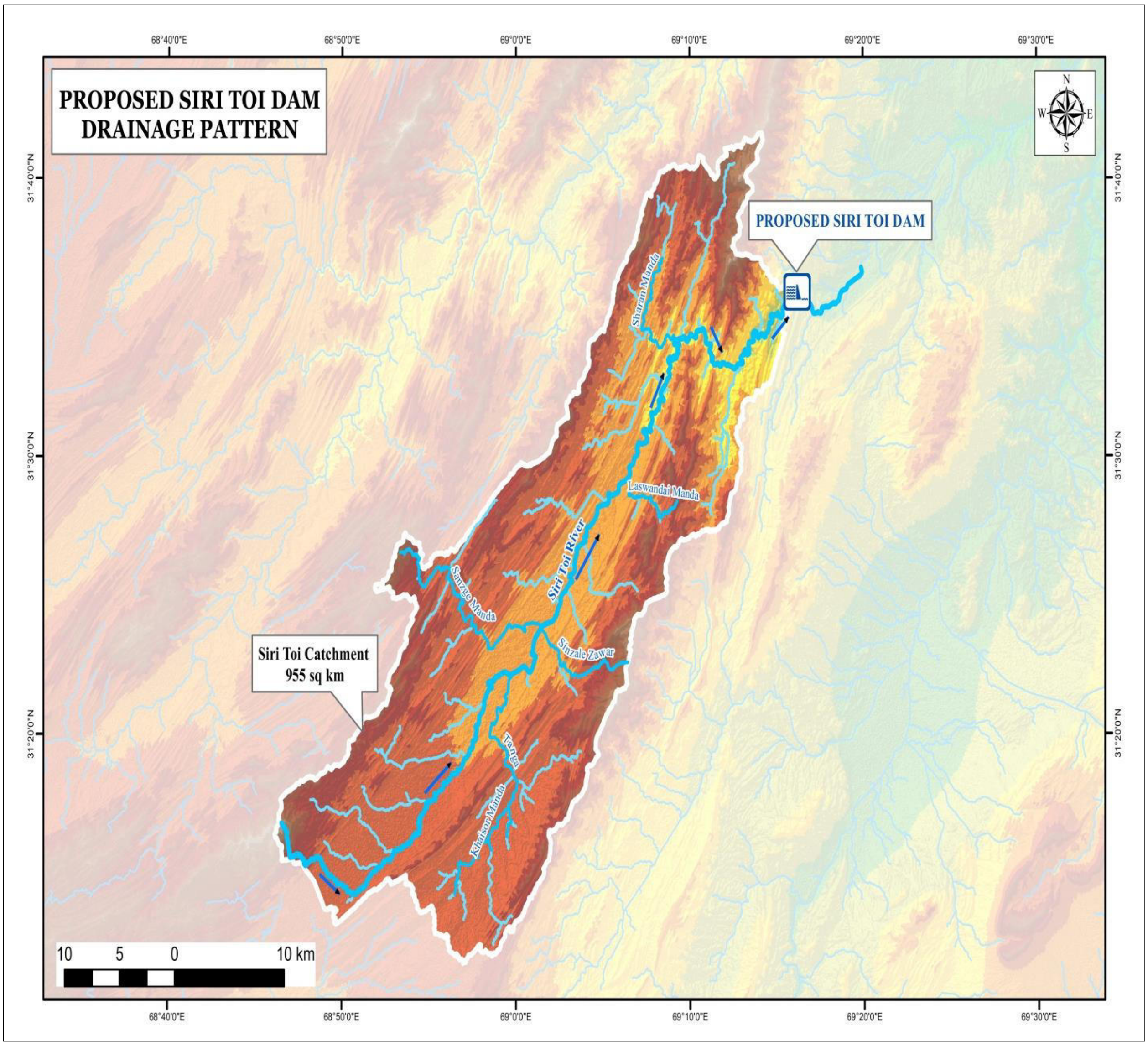


Figure 10 - Proposed Siri Toi Dam Drainage Pattern

140. Pishin Basin forms the boundary zone between Afghan Block and Indian Plate. Pishin basin is filled with more than 6000m thick flysch-molasse.Zhob District is proposed for detailed Geological Mapping to establish stratigraphic sequence and geophysical survey to interpret the structural setup of the basin.

141. This area is situated close to Zhob Basin, represented by an anticlinorium, in which the geological sequence very silently shifts from older Triassic, Jurassic and Cretaceous Strata to Non-confirmity, Eocene (Nisai Fm), Oligocene (Murgha Faqirzai Fm), Miocene (Shaigalu Fm), Pleistocene (Bostan Fm) and Holocene (Zhob river deposits) towards the investigated area. The area is structurally not so much disturbed and shows rather complete stratigraphic sequence.

142. The belt is subdivided into six tectono- stratigraphic zones bounded by major thrusts, which evolved in response to continued compressional tectonics (Fig. 10), each zone has its distinct lithostratigraphy Table 19. The Muslim Bagh-Zhob Ophiolite and associated mélanges exposed along the northwestern margin of the Indian Plate marks the base and Zone-I of this belt. On top of the Muslim Bagh Ophiolite lies Zone-II, comprising the Eocene Nisai Formation (Hunting Survey Corporation, 1960; Cheema et al., 1977) and the Oligocene-Early Miocene Khojak Formation (Bender and Raza, 1995). The Nisai Formation has a non-

conformable contact with the underlying Muslim Bagh Ophiolite and is conformably overlain by the Khojak Formation. The Dash Murgha group overlies the Nisai Formation with angular unconformity. The Late Miocene-Pliocene Malthanai formation makes up Zone-IV. Its lower and upper contacts with the Nisai Formation are thrusted. The Pleistocene Bostan Formation (Hunting Survey Corporation, 1960) makes up Zone-V. Its contact with the Malthanai formation is also thrusted. Further, the flat-laying Holocene Zhob Valley deposits comprise Zone-VI of the belt, which has thrusted contact with the Pleistocene Bostan Formation.

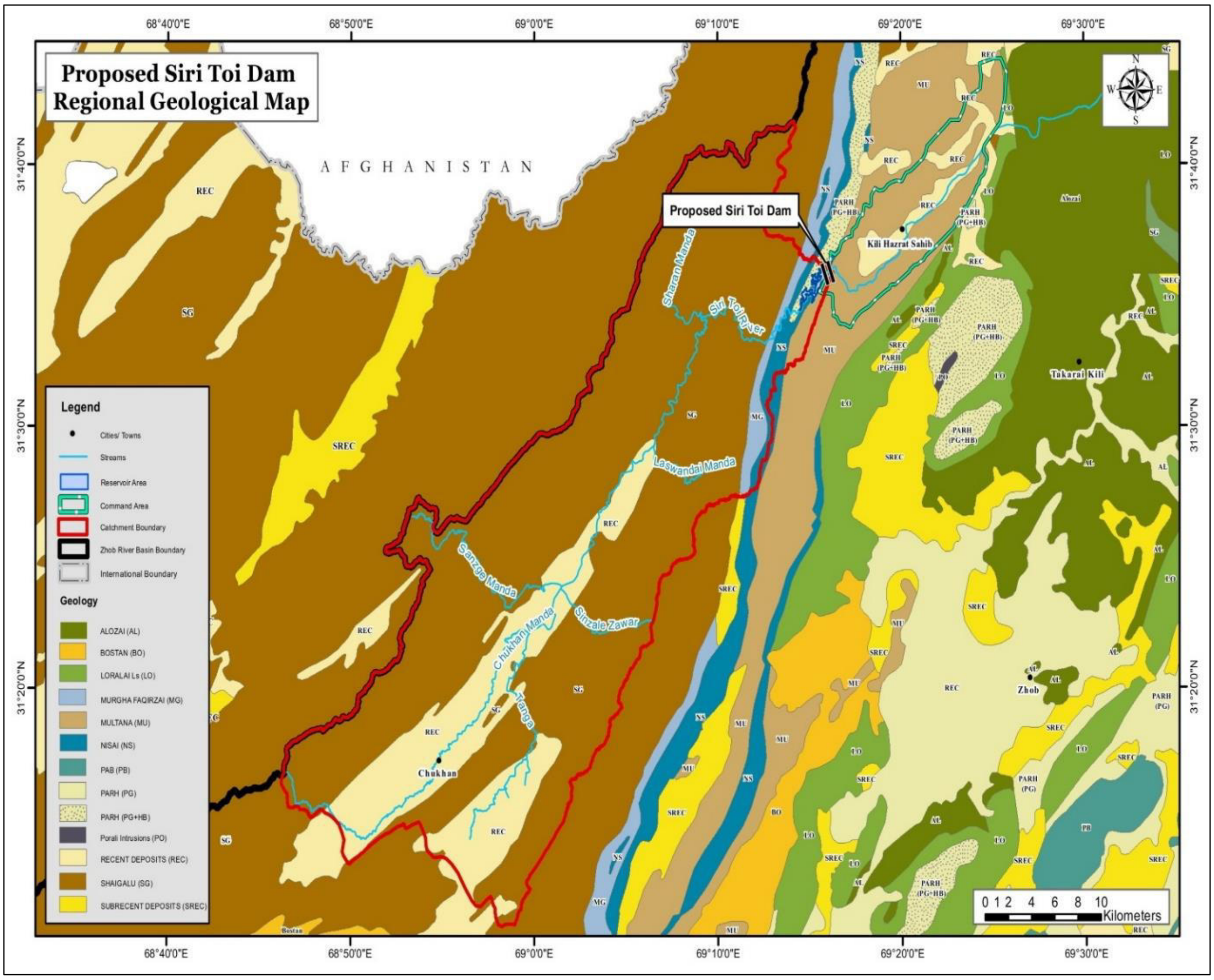


Figure 11 - Proposed Siri Toi Dam Regional Geological Map

Table 20 - Proposed tectono-stratigraphic zones and lithostratigraphy of the Pishin Belt and surrounding areas [(modified after the Hunting Survey Corporation (1960) and Cheema et al. (1977)]

Age	Formation/ Member	Lithology	Tectono- stratigraphic Zones
Holocene	Zhob River Deposits	Conglomerate, sandstone and shale / siltstone.	Zone VI
	Thrust		
Pleistocene	Bostan Formation	Red colored shale/siltstone, conglomerate and sandstone.	Zone V
	Thrust		
Late Miocene-Pliocene	*Malthanai Formation	Sandstone/ conglomerate interceded with red colored mudstone/siltstone.	Zone IV
	Thrust		
Oligocene –Early Miocene	Khojak Formation Shaigalu Member Murgha Faqirzai Member	Dominantly sandstone with subordinate shale Dominantly shale with subordinate sandstone	Zone II
Eocene	Nisai Formation	Highly fossiliferous to reefoid limestone interbedded with marl and shale and thick marine (fossiliferous) shale with occasional thin limestone horizons.	
	Nonconformity		
Cretaceous	Muslim Bagh- Zhob Ophiolite	Mostly ultrabasic and basicigneous rocks	Zone I

NOTE: The name "Malthanai Formation" has been modified after the Multana Formation of Hunting Survey Corporation **(1960).**

6.8 Detail of Regional Geology and Tectonic Zones

6.8.1 Zone-1

Muslim Bagh Ophiolite

143. The Muslim Bagh Ophiolite is believed to be a relic of the oceanic floor of the Neo-Tethys, which was obducted onto the Indian Plate subsequent to closure of Neo-Tethys and collision of the Indian Plate with Afghan Block of the Eurasian Plate at the Cretaceous-Tertiary boundary or later in Paleocene-Early Eocene time (Allemann, 1979; Sarwar, 1992; Ahmed, 1996; Gnos et al., 1996). The age of the emplacement of the Muslim Bagh Ophiolite has been determined as 65-70 Ma by 40Ar/39Ar dating (Mahmood et al.1995). The ophiolite consists of an upper and a lower nappes; the upper nappe is composed of ultramafic rocks intruded by gabbro plutons and dolerite dykes, whereas the lower nappe comprises pillow basalts and sediments underlain by mélange of ophiolitic rocks and sediments (Khan et al., 2007a). The Muslim Bagh Ophiolite is non-conformably overlain by the Eocene Nisai Formation.

6.8.2 Zone-2

Nisai Formation:

144. The name Nisai Group was proposed by Hunting Survey Corporation (1960) after the Nisai village for the “black nummulitic limestone” of Vredenburg (1904) and “older nummulitic beds” of Davies (1930). Cheema et al. (1977) redefined the unit as Nisai Formation. A section exposed 12 km north of the Nisai railway station was designated its type section, where it is 1200 m thick (Hunting Survey Corporation, 1960). The Nisai Formation is mainly exposed along the Zhob Valley Thrust, however, it is also widely exposed in the Sharan Jogazai area, west of the Dasht Murgha Syncline.

145. The Nisai Formation comprises limestone, marl and shale with subordinate sandstone and conglomerate. The formation has been divided into lower, middle and upper parts at the type section (Kazmi and Abbasi, 2008). The Lower part contains dark grey to brownish grey argillaceous limestone and pale grey shale, which contains thin platy beds of white sandy siltstone. The middle part is dominantly shale with subordinate limestone, marl and sandstone. The shale is calcareous, sandy, fissile and pale grey to greenish grey in colour. The sandstone is greenish grey, fine grained and calcareous. The Upper part of the formation contains mainly limestone and sandstone with thin shale and conglomerate layers. The limestone is light grey to light brownish grey and highly fossiliferous. The conglomerate consists of poorly rounded pebbles and boulders of igneous rocks, marl, limestone and jasper.

146. Hunting Survey Corporation (1960) assigned an Early Eocene to Early Oligocene age to the Nisai Formation based on faunal assemblages. Allemann (1979) studied the oldest carbonate strata overlying the Muslim Bagh Ophiolite and suggested an Early to Middle Eocene age, whereas Qayyum (1997) assigned a Late Paleocene to Early Oligocene age on the basis of following foraminiferal assemblages: Early Oligocene: Nummulites fichteli.

147. The Nisai Formation has been deposited in shallow water carbonate platform environment, as well as in deep water slope and basin environments, as revealed by turbidite facies (Qayyum, 1997). The Nisai Formation is conformably overlain by the Khojak Formation.

6.8.3 Zone-3

Khojak Formation:

148. The Khojak Formation, named after the historic Khojak Pass near the town of Chaman, was mapped as Khojak Shale by Vredenburg (1909). Hunting Survey Corporation (1960) divided the formation into a lower shale-dominant succession, the Murgha Faqirzi Member, and an upper sandstone-dominant succession, the Shaigalu Member. Qayyum et al. (1996, 1997a) retained the same classification for the lower shale-dominant succession and upper sandstone- dominant succession. We also prefer to use the same terminology for the upper and lower members. In the Chaman area thickness of the Khojak Formation exceeds 6300 meters.

Two members:

- Murgha Faqirzai member
- Shaigalu member

Murgha Faqirzai Member:

149. The Murgha Faqirzai Member is named after the Murgha Faqirzai village of Qila Saifullah District. The Rud Faqirzai section is proposed as the reference section for the Murgha Faqirzai Member, where it is 2000 m thick (Hunting Survey Corporation, 1960).It is composed dominantly of shale or slate of greenish grey and olive grey colour, interbedded with sandstone, siltstone and occasional beds of shelly limestone. The Lower part of the member is composed of rhythmically interbedded greenish grey and olive grey shales, sandstone/siltstone. The Middle part is dominated by siltstone, very fine grained sandstone, shale and mudstone. In the upper part shale intervals are very thick.

150. Metamorphism of the sediments is common in the areas that are close to major thrusts, where the shale has been metamorphosed to slate and phyllite, and the sandstone is converted to quartzite and schist. Hunting Survey Corporation (1960) has assigned it an Oligocene age on the basis of foraminifera. The Murgha Faqirzai Member rests conformably and transitionally on the Nisai Formation, whereas its upper contact with Shaigalu Member is also transitional.

Shaigalu Member:

151. This member is named after the Shaigalu militia post situated about 50 km southwest of Zhob which is also the reference section for the Shaigalu Member (Hunting Survey Corporation, 1960).The Shaigalu Member is dominantly composed of sandstone interbedded with minor proportion of shale. The sandstone is light grey to greenish grey medium to coarse grained and thick bedded, with some beds up to 10 m thick. Shale is pale green, flaky and calcareous. Qayyum et al. (1996) has divided this member into three parts at the Manzakai section, where it is 3, 950 m thick. The lower part is 661 m thick succession, composed of numerous thickening-up cycles of medium to thick bedded, flat to amalgamate and hummocky-cross bedded sandstone with laminated greenish grey siltstone and shale. The middle part is 698 m thick succession containing numerous finning-up cycles of trough- to planar- cross bedded sandstone interbedded with intensely bioturbated, greenish grey to chocolate brown siltstone and mudstone. The upper part is 591m thick sandstone succession which is thick to very thick bedded, cross bedded, ripple laminated and have scoured into multicoloured mudstone. The mudstone also contains lenses of sandstone, siltstone, rare coal beds and soil horizons. According to Qayyum et al. (1996) the Shaigalu and Murgha Faqirzai members were deposited in a wave-modified fluvial-dominated delta system. On the basis of foraminiferal assemblages the Hunting Survey Corporation (1960) assigned an Oligocene age to the Shaigalu Member. Its upper contact is not known in the study area.

6.8.4 Zone-4

Malthanai Formation:

152. the authors propose the name Malthanai formation for the Multana Formation of Hunting Survey Corporation (1960), after the Malthanai village near its type section. “Malthanai” a Pashto word for a small business of salt cropping from brackish water springs, emerging along the contact of Nisai Formation with Malthanai formation or Dasht Murgha group around the vicinities of Kazha Merzai, Gardab Manda, Malthanai Kili (near the type section) and Sur Kach areas. The name “Multana” introduced by Hunting Survey Corporation does not convey any relationship with the local geographic names and therefore is misleading. Hunting Survey Corporation (1960) correlated it with the Shaigalu and Murgha Faqirzai members of the Khojak Formation and considered it as a "conglomerate axial belt

facies" of these members. The formation is 2500 m thick at its type section [Oblin Nala section, (N 31° 02' 15" E 69° 04' 41").]

153. The formation comprises sandstone interbedded with siltstone, mudstone and conglomerate. Ratio of the sandstone and mudstone/siltstone is roughly equal. Sandstone is mostly reddish grey, partly greenish grey, generally fine to very fine grained and medium to coarse grained in the lower and middle parts and very coarse to pebbly in upper part. Sandstone is very thin to very thick bedded, soft and friable. It occurs as medium to thick, lenticular beds and fine grained thinly bedded sandstone/siltstone–mudstone couplets. Amalgamation is common in thick beds which exhibit parallel lamination, cross bedding, ripple-cross lamination, and large ripples and dunes on tops. Mudstone is massive and mostly reddish grey to maroon. Pebbly sandstone and conglomerate beds are also present in upper part of the formation. Conglomerate contains abundant chert / jasper, subordinate limestone, sandstone, siltstone and mudstone intraclasts, and minor proportion of basic or ultrabasic fragments. In upper most part of the formation very thick bedded (up to 6 m thick) conglomerate beds appear, having maximum clast size of up to 50 cm. The cobbles and boulders are well rounded, moderately sorted and clast supported. They have erosive bases having very large size load casts and longitudinal ridges and furrows at their bases. The framework grains comprise limestone fragments derived from the Nisai Formation and sandstone fragments of the Khojak Formation. Near the type section the Malthanai formation has thrusted contact with the Pleistocene Bostan Formation, whereas lower contact is an angular unconformity with the Nisai Formation. Based on its tectono-stratigraphic position (Zone-IV), we envisage that it is younger than the Dasht Murgha group and may be of Late Miocene-Pliocene age. Stratigraphic position a Pleistocene age has been proposed (Cheema et al., 1977). Its contacts with the Malthanai formation and flat-lying Holocene deposits of the Zhob valley are thrusted. We envisage that it overlies the older rock successions with an angular unconformity.

Figure 12 - Shale dominant packages interbedded with thin sandstone beds in the Malthanai formation. Photograph was taken looking northeast, cycle is 23 meters thick.

Figure 13 - Thick bedded sandstone with large size load casts at its base in the Malthanai formation. Photograph was taken looking northeast

Figure 14 - Distant view of the conglomerate, and sandstone and shale cycles within the Bostan Formation. Photograph was taken looking northwest. Cycle is 50 meters thick.

Figure 15 - Close up view of the poorly sorted and well-rounded boulder conglomerate of the Bostan Formation. Photograph was taken looking northeast

6.8.5 Zone-5

Bostan Formation:

154. The Bostan Formation has been named by the Hunting Survey Corporation (1960), after the village of Bostan, 30 km north of Quetta. The Pishin Lora (Pishin District) is designated as its type section. In the Zhob valley area the formation comprises cyclically interbedded packages of conglomerate, mudstone and sandstone and reaches up to 1250 m in thickness at Gardab Manda section near Qila Saifullah. In the type section the formation is dominantly red colored mudstone with minor proportion of sandstone and conglomerate. However in the Zhob Valley conglomerate dominates over sandstone and mudstone. Conglomerate is very thick bedded and composed mostly of cobble- to boulder-size, and subordinately pebble size fragments. It is clast supported, having coarse sandstone matrix, well rounded, poorly sorted and showing pronounced imbrication. Conglomerate is composed of various types of rock fragments including basic igneous, ultramafic, metamorphic, sandstone and limestone varieties.

155. Sandstone and siltstone is often very soft and poorly lithified. Sandstone is light brownish grey and greenish grey, thick bedded, mostly medium to very coarse grained and in places pebbly to cobbly. Sandstone beds mostly display parallel- lamination, cross-bedding/lamination and bioturbation. Mudstone is massive, silty and light reddish to brownish grey and reddish brown. The Bostan Formation has not yielded any age-diagnostic fossils, however, on the basis of its stratigraphic position a Pleistocene age has been proposed (Cheema et al., 1977). Its contacts with the Malthanai formation and flat-lying Holocene deposits of the Zhob valley are thrusted. We envisage that it overlies the older rock successions with an angular unconformity.

6.8.6 Zone-6

Zhob Valley Deposits:

156. The Zhob valley deposits are thick flat-lying Holocene deposits, covering wide area of the Zhob valley. They are dominantly composed of mudstone interbedded with subordinate

sandstone/siltstone and/or pebbly conglomerate. These deposits are very loose and friable. Due to its flat-lying and loose character, we envisage that they are of Holocene age.

6.8.7 Discussion about Regional Geology of Siri Toi Dam Area:

157. The Pishin Belt has evolved along the western- northwestern margin of the Indian Plate during its oblique collision with the Afghan and Kabul Blocks of the Eurasian Plate, 55 Ma before, around the Palaeocene-Eocene boundary (Searle et al., 1997; Khan and Sirivastava, 2006). The Belt accommodates sedimentary succession, deposited in the Katawaz Basin, a south and southwestern extension of the remnant Neo-Tethys Ocean (Qayyum et al., 1997a, 1997b). The Late Palaeocene-Eocene Nisai Formation was deposited as shallow to deep marine limestone and shale succession during Late Palaeocene-Eocene times on top of the Muslim Bagh Ophiolite. We consider the Muslim Bagh-Zhob Ophiolite as our tectono-stratigraphic Zone-I, which is the base of the Pishin Belt. The Nisai Formation overlies the Muslim Bagh Ophiolite with non-conformity. The Late Eocene- Oligocene Khojak Formation, conformably overlying the Nisai Formation, represents a molasse- delta-fan continuum of the Palace-Indus River, which derived its siliciclastic detritus from the nascent Himalayas (Qayyum et al., 1997b; Carter et al., 2010). The Murgha Faqirzai Member of Khojak Formation represents a submarine fan facies, whereas the Shaigalu Member is composed of fluvial-dominated and wave modified deltaic facies (Qayyum et al., 1997a). We consider the Nisai and Khojak formations jointly to comprise our tectono- stratigraphic Zone-II. Subsequent closure of the Katawaz Basin, towards the end of Early Miocene, caused to uplift and expose the Nisai and Khojak formations, which were deformed into NE-SW trending and E-SE verging folds (Qayyum et al., 1994). Due to the Chaman transform fault the western margin of Pishin Belt is dominantly transpersonal, however, its deformational style gradually changes to compressional toward the east (Tremor and Pizza, 1993). Imbrication of the frontal parts of the thrust-wedges, through a series of emergent thrusts, built the topography along the eastern margin of the basin. The relative subsidence of footwalls to the SE of major thrusts subsequently provided accommodation for the fluvial succession of the Dasht Murgha group (our Zone- III). Continued compression caused uplifting and exposure of the older units, the Muslim Bagh Ophiolite (Zone-I) and Nisai and Khojak formations (Zone-II) that subsequently became the source terrains for the fluvial succession of the Dasht Murgha group (Zone-III), which was in turn uplifted by continued compression that provided accommodation for another fluvial succession of the Malthanai formation (Zone-IV). Further compression continued and caused uplifting and deformation of the Late Miocene-Pliocene Malthanai formation, providing space for deposition of fluvial succession of the Pleistocene Bostan Formation (Zone-V). Such relationships are evident from the major thrusts between these zones. Active tectonics of the Pishin Belt is evident from the folding and thrusting of the Pleistocene Bostan Formation, which has been thrusted over the flat-lying Holocene deposits of the Zhob valley (Zone-VI). Angular unconformity under the deformed succession of the Bostan Formation and flat-lying Holocene fluvial deposits of the Zhob valley suggests that deformation continued during the Pleistocene times and the area is still tectonically active. Recent movements along the Chaman transform fault and presence of the neotectonic features along the eastern margin of the Pishin Belt are the further evidences of the active tectonism in the area (Lawrence et al., 1992).

6.8.8 Inference about Regional Geology of Dam Area

158. The Pishin Belt possesses distinct lithostratigraphy within six well defined thrust-unconformity-bounded tectono-stratigraphic zones. Zone-I represents the Muslim Bagh-Zhob

Ophiolite, whereas Zone-II comprises the marine to fluvio- deltaic successions of the Late Palaeocene-Early Miocene Nisai and Khojak formations. Zones-III, IV, V and VI are Middle Miocene-Holocene fluvial successions of Dasht Murgha group, Malthanai formation, Bostan Formation and flat-lying Holocene deposits of the Zhob valley respectively. These tectono-stratigraphic zones and their respective lithostratigraphic units developed in response to an amalgam of continued transpressional and compressional deformation along the western margin of the Indian Plate.

6.9 Structure Geology of the Dam Site Area

159. Tectonically the region of dam site is situated in the vicinity of a number of active faults like Kakar Khorasan fault in the north and the Zhob Valley Thrust in the south. Both these faults are trending northeast-southwest. The area is in the near vicinity of subduction zone of Pakistan- India Plate and Eurasian Plate. Due to continuous subduction activity the rocks have undergone immense folding and faulting. A large number of east-west trending folds, existing in the north of the area have been mapped by GSP.

6.9.1 Dam Site Geology

General

160. Main rocks are covered in dam site area is mainly sedimentary in nature. The dam site is located in narrow gorge. The recent alluvium is present in the river bed and consists of rounded and sub-rounded gravels and boulders with some sand and fine particles. Abutments comprise of very steep slopes having 75 to 80 NW dip almost vertical in outcrop. The site having rock of Eocene, Oligocene and Miocene age prominent at that location. As Describe below:

Table 21 - Dam Site Geology of the Siri Toi dam

Formation	Age	Lithology	Location	Strike	Dip & Dip Direction	Fold Axis
Malthanai Formation	Late Miocene	Sandstone/ Conglomerate Interceded With Red Colored Mudstone/Siltstone	Main Dam	Ne/Sw	700 To 820 In N-W Direction	Syncline Fold Axis
Nisai Formation	Eocene	Thick Marine (Fossiliferous) Shale With Occasional Thin Limestone Horizons.	Dyke	Ne/Sw	780 To 800 In N-W Direction	Anticline Fold Axis
Nisai Formation & Parh Group	Eocene & Paleocene To Late Cretaceous	Thick Marine (Fossiliferous) Shale With Occasional Thin Limestone Horizons & Volcanic Group/Shale.	Spillway	Ne/Sw	580 To 650 In N-W Direction	Core Of Anticline Fold Axis

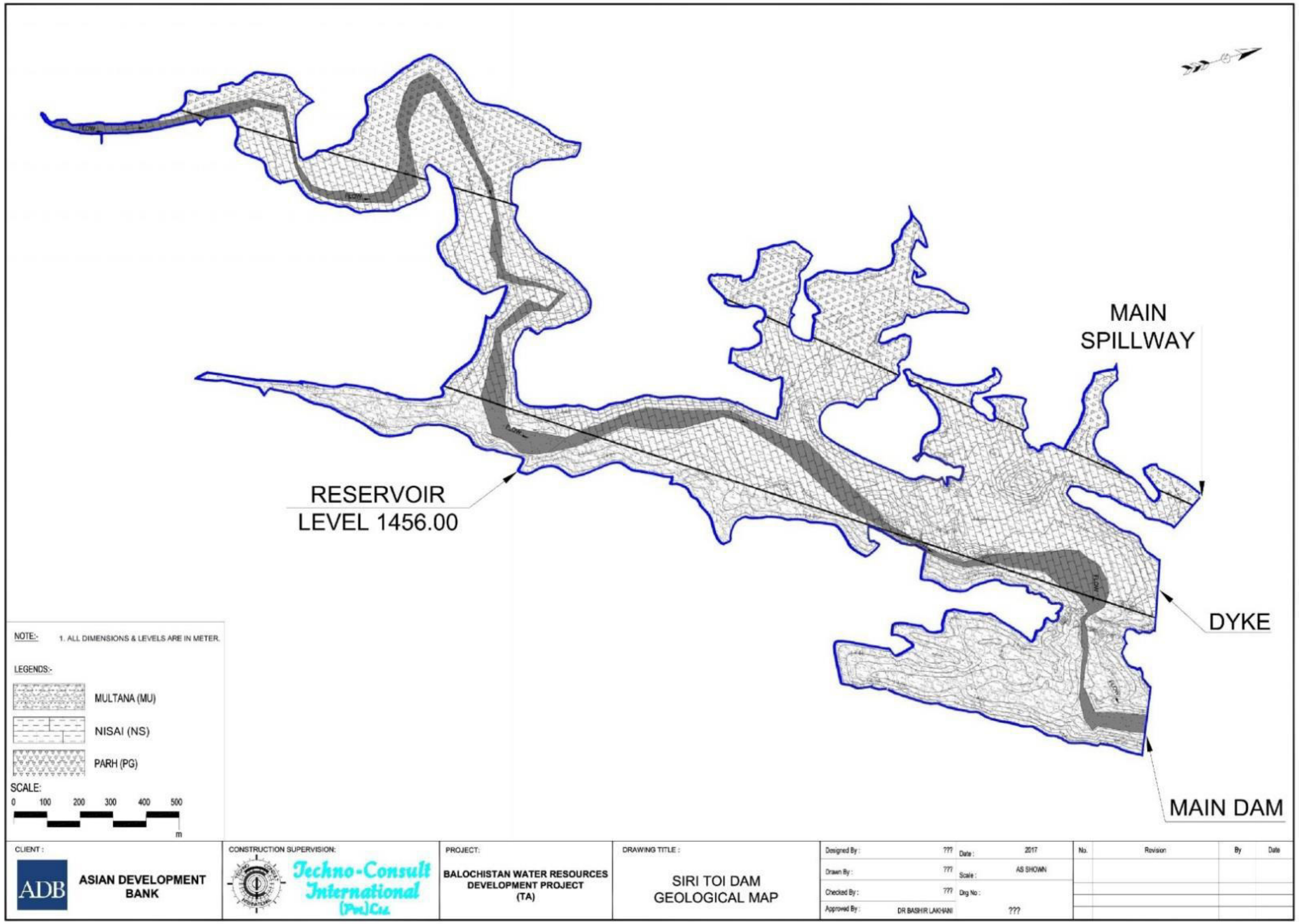


Figure 16 - Siri Toi Geological Map

Left Abutment

161. The left abutment contain Malthanai, Nisai and Parh group having lithology describe above in the table. Having generally anticline fold axis with steep to gentle slope from Malthanai formation to Parh Group with dipping generally in NW direction with amount of dip varies as 650 to 800.

Right Abutment

162. The right abutment mainly contain Malthanai Formation having lithology sandstone, shale and conglomerate with the dipping angle almost vertical having joints and minor sedimentary structures.

Figure 17 - Right & Left Abutments of Siri Toi dam

River Bed

163. The valley portion of the proposed dam consists of two parts, the channel and the terrace. The channel of Zhob River comprises of varying sizes of rounded to sub-rounded gravels and boulders of heterogeneous nature with some sand and fines. It is estimated that the thickness of this overburden is about 6 to 8 m (19.70 ft. to 26.3 ft.). The terrace, a vast plain exists in between the channel and the right abutment. The exposed rock in the terrace is sandstone and conglomerate. These rocks are coarse to fine grained, thinly to moderately bedded, grey to red in colour, moderately strong, slightly too moderately weathered near surface and closely to moderately joint.

Figure 18 - River Bed of Proposed Siri Toi dam

Reservoir Area

164. The reservoir floor is covering area almost 1.67sq.Km and the reservoir level is about 1459.5 m. It is consisting mainly on alternation of thick layers of impervious sandstone and shale somewhere conglomerate. These rocks are appearing in outcrop friable and loose but they are firm and sound below surface. Therefore the site has enough stability and watertight to be used for dam building. There is no fault near the dam site area, some existed fault in the area are too far to have any effects on the dam stability. As concerned to hydrogeological view, there is no any leakage or discharge of water. This is attributed to the imperviousness of the rock layers below the dam side and reservoir. The rocks exposed in the reservoir area in the vicinity of the dam and beyond are shales and sandstone with flaggy sandstone belonging to the formations of Oligo-Miocene age. These rocks in the reservoir area are quite stable and there is little danger of any large scale sliding in the reservoir.

Figure 19 - Proposed Reservoir Area of Siri Toi dam

6.9.2 Physiography and Drainage

Main Dam Axis

165. The main Dam will be constructing on Malthanai formation (previous name Multana formation having lithology shale, sandstone and conglomerate) which was eroded by water flow that make stream as shown below the newly sediments of Holocene age were deposited

by Zhob river. The dam site is located in front of small ridge which transected (cut traversals) by seasonal stream. Thus small gorge is formed which is about 100m wide at its base.

Figure 20 - Proposed Main Dam Axis at Siri Toi River

Spillway

166. A non-overflow Earth-fill Dam has been selected with a spillway channel located outside of the limits of dam abutments to ensure dam safety with geological aspect it will be constructing in between Nisai formation and Parh group having thick layer of shale and thin beds of limestone observed some volcanic group also reported there by GSP. Minimum freeboard of 2.5m is provided between the maximum flood level and the top dam crest elevation 1462m. The upstream end of the crest is joined with the approach channel by a 1V:1H slopping face. The downstream end of the crest connects to a 1V:4H with steep spillway chute. It design for a 10,000 year return period flood. Head design is 3.6m with a crest length of 135m. Its crest level is set at a level of 1459.5 m.

Dyke

167. It will be constructing on Nisai formation of Eocene age having thick marine (fossiliferous) shale with occasional thin limestone horizons as shown below:

Figure 21 - Proposed Dyke Location at Siri Toi dam

Catchment Area

168. The stream drains a catchments areas has more than 960.5 square kilometers which may supply enough runoff, in winter and spring to fill a dam of 66-m height. The catchments area is mainly hilly terrain and characterized by dendritic drainage pattern as shown.

Reservoir Area

169. The reservoir floor is covering area almost 1.73sq.Km and the reservoir level is about 1459.5 m and approximately its length is about 4.5Km. It is consisting mainly on alternation of thick layers of impervious sandstone and shale somewhere conglomerate. These rocks are appearing in outcrop friable and loose but they are firm and sound below surface. Therefore the site has enough stability and watertight to be used for dam building. There is no fault near the dam site area, some existed fault in the area are too far to have any effects on the dam stability. As concerned to hydrogeological view, there is no any leakage or discharge of water. This is attributed to the imperviousness of the rock layers below the dam side and reservoir. We leave hydrological condition of the valley stream to the hydrological team to evaluate the rate of sedimentation and flood hazard analysis of the watershed in addition to water budget of the valley.

Command Area

170. It is expected that construction of the proposed dam will cover the command area up to 4,027 ha, beside of sustained water supply to the present command area being cultivated on seasonal basis by growing vegetables and grains. The proposed reservoir would recharge the subsurface flow of karezes, shallow wells and tubewells, protect the agriculture land and human settlements from devastation of floods during flood seasons and develop grazing zones for livestock. The stored water will support drinking, agriculture purpose and other domestic uses. The mean altitude of the command area is 1350 m above mean sea level. It covers different types of lithological variation in it. Age ranges from Triassic, Jurassic, cretaceous and sub-recent to recent having lithology as shale, limestone, volcanic group and river deposits with major in sand or other sub-recent particles.

6.10 Recommended Geology Studies

171. Considering the hints of seismic activities near and/or surrounding area of proposed dam sites in the available geology literature it is advised that comprehensive Seismic-Tectonic studies will be required during detailed design stage of the project. Details about subsurface conditions will be added to this chapter after completion of geotechnical Investigation works which is expected to be completed during next month.

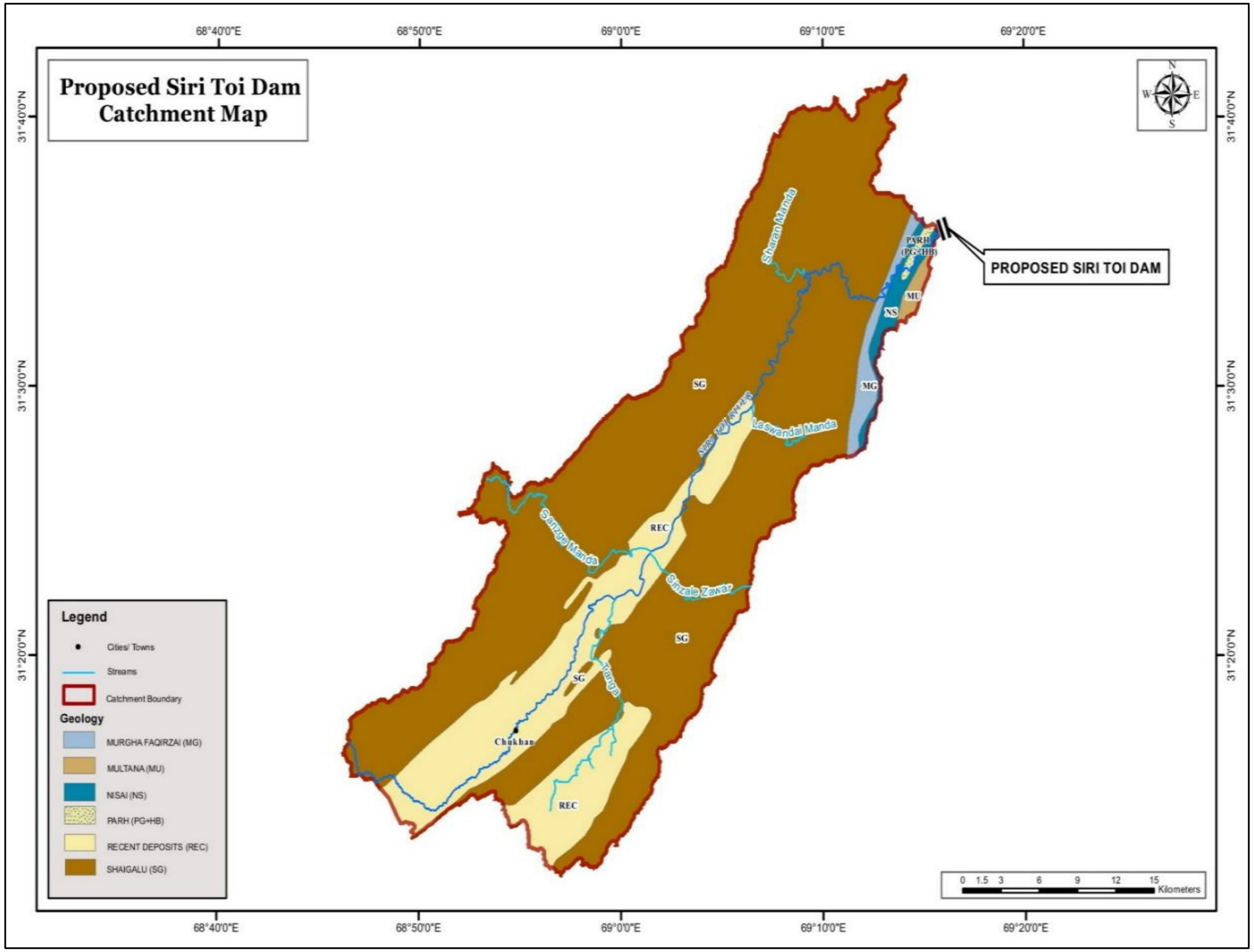


Figure 22 - Proposed Siri Toi Dam Catchment area

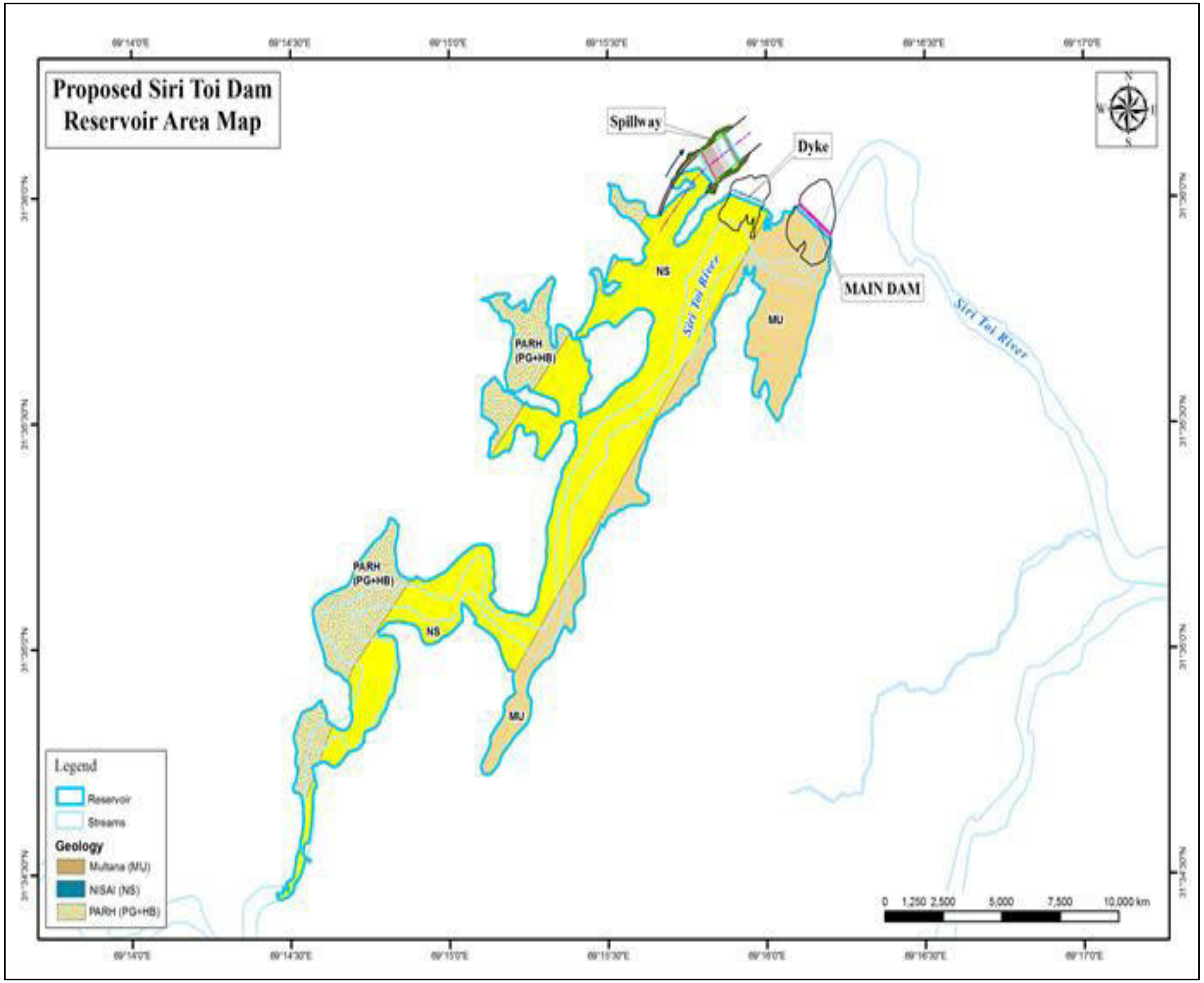


Figure 23 - Proposed Siri Toi Dam Reservoir Map

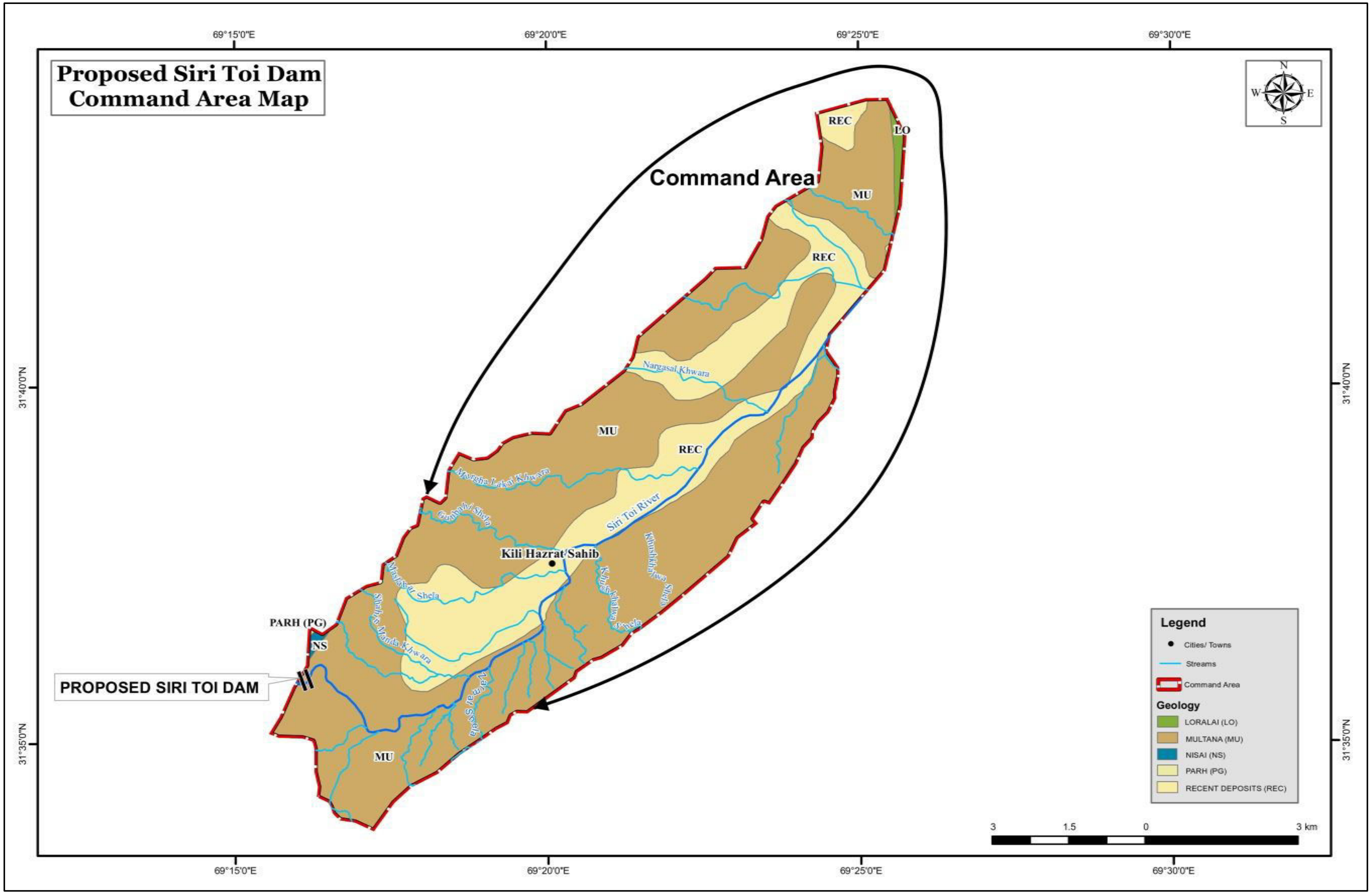


Figure 24 - Proposed Siri Toi Dam Command Area Map

7 General

172. The planning of dam structure mainly involves the determination of optimum project layout and selecting the type of dam and its appurtenant structures. The topography, hydrology and geology all play their role in locating the project components. Accordingly, the Consultants have carried out the project layout study with due consideration to topographical, geological and hydrological parameters of the proposed dam site.

7.1.1 Topography

173. Siri Toi has several narrow and steep canyons along the main river alignment. Some distance downstream of the proposed dam axis the valley opens wide to a relatively flat area on both sides of the river banks having an average width of around 2-km. Several small and medium height mounds lie in this area that is excluded from the command area. In order to fulfill the irrigation requirement of 30 MCM for the design command area a 66 m high dam was required. Therefore, primarily a location where abutment hills exceeding 66 m was identified. A suitable dam location that would require minimum number of dykes for the reservoir rim was sought which was identified few kilometers upstream of the proposed command area.

7.1.2 Availability of Material

174. For rockfill or central clay core earhfill dams it is necessary to identify the closest and most easily accessible borrow areas for construction material near the periphery of the dam site. The availability of construction material is an essential material in selecting the type of dam. Once the available material is identified it requires extensive geotechnical testing and quality screening to assure the fulfillment of design requirements.

7.1.3 Planning and Optimization of Alternate Project Layouts

175. The study of alternative project layouts was conducted based on relevant studies. These studies included assessment of the site conditions, geological and geotechnical conditions, hydrology, sedimentation, flood studies and optimization of design command area. Based on the criteria finalized various alternative project layouts were prepared and technically compared together with the cost and benefit considerations. Brief summary of the options are discussed below:

Table 22 - Alternate Project Layouts

No.	Option	Reasons for Selection/Rejection
1.	Perennial and Flood Irrigation Scheme (Weir PIS+FIS)	Since perennial flow is available at Siri Toi, initially a weir diverting water to separate flood and perennial channels was considered as an economical option. However, the river has subsurface flow during few months which cannot be intercepted through construction of a weir during low flow seasons. Furthermore, flash floods occur frequently in this area and the floodwater cannot be reliably utilized for the design command area without proposing a storage structure. Therefore, preliminary studies of this option revealed that proposing a weir will limit the extension of the command area without full exploitation of the area potential. Therefore, this option was later abandoned.
2.	Infiltration Gallery	As a second design alternative, an infiltration gallery was considered. This option was suitable particularly for intercepting low subsurface flows. But the abundant surface water particularly during high flow seasons and in floods will pass the project area un-utilized and the total command area would be significantly reduced. The topography of the area is very steep therefore; the conveyance conduit from the infiltration gallery would lose a huge patch of cultivable land till the daylight point. Infiltration galleries are also susceptible to damages due to riverbed scour during flash flood. Therefore, this option was unfeasible.
3.	Dam	A storage dam was evaluated as the best option based on the project location hydrology, topography and available land. A dam will fulfill almost all the necessary requirements to utilize the potential of the area which include; storage of flood water for reliable perennial irrigation, protection of command area from severe floods, maximum utilization of available land for the design command area and water supply assurance for the domestic purposes. The comparison of alternate dam options and layout are discussed below:

176. Several options and axes where compared for the most optimum dam configuration in the area valley. Few options are discussed here that also includes cascades of three 15-m high dam. The Area - Elevation- Capacity curve for three small 15-m dams gave a combined storage capacity of only 0.96 MCM. The average annual available water for this project is 57 MCM indicating probable operation of all three spillways every year. Furthermore, such a small storage capacity will soon be silted up as a sediment inflow estimates show that a dead storage of at least 10-15-m is required on this steep terrain. The terrain of the area being extremely steep with narrow contour areas at lower elevation make small dams unfeasible for this location and only a high dam can fulfill the requirements of assured perennial irrigation supply to the design command area.

177. Two suitable options were analyzed in detail, option-1 with a dam crest length of 993-m and option-2 with a dam crest length of 231-m. Both axes are located close to each other nearly 400-m apart. The layout of the two options is shown in **Error! Reference source not ound.**. The comparison between the two options is shown in Table 23 - Comparison of Options (Axes) -1 & 2. .

Table 23 - Comparison of Options (Axes) -1 & 2

Description	Option-1	Option-2
Dam crest length (m)	993	231
Total Infrastructure Cost (Million Rs.)	7,845	4,743
Spillway Cost (Million Rs.)	1,395	1,168
Dam Body (Million Rs.)	4,644	1,085
Storage at MCL (MCM)	51	36.5
Command Area (hectares)	4027	4027

178. For detailed comparison of the two options, reservoir operation simulation was carried out for 35 years (1979-2014) based on the input data of rainfall, evaporation, inflow, target releases, spills and gradual reservoir depletion due to sedimentation. The operation simulation was carried out considering increasing sedimentation levels in reservoir. The reservoir operation results showed that the shortages of target irrigation supply computed for the design command area of 4027 hectares for option-2 are 12% representing an irrigation supply reliability of 88% for the 51 MCM (larger reservoir capacity). Similarly, reservoir operation for option-2 with storage of 36.5 MCM showed an irrigation supply reliability of 82% with a shortage of 18 % over 35 years of operation.

179. The increased storage in option-1 will store more water during flood years with lesser spill chances. However, the benefits obtained from the increased storage are restricted as the command area extension beyond 4027 hectares is limited by the land available in the project area. The infrastructure cost of option-1 is nearly 1.62 times greater than the cost of option-2 with slightly higher benefits of longer design life and additional floodwater storage during extreme years (providing irrigation target reliability of 88%). Option-2 has slightly lesser benefits but the total cost offset advantages of option-1and has been selected as the viable option.

180. The final selected option (option-1) is a 66-m high clay core earthfill dam with one 234-m dyke and an overflow spillway located at some distance from the left abutment of the dyke.

7.1.4 The Layout Planning

181. The general layout plan of Siri Toi Dam project presented in Drawings and Maps (Annexure A) of this report includes the dam location, intake and outlet structures, spillway, canal networks and its distribution. Based on site geological conditions and availability of embankment materials, a traditional Central Clay core earth fill dam is proposed in the deepest valley section with a spillway arrangement to cater for the peak flood flows.

182. Spillway is placed on a small hill flanked by main dam and saddle embankment on its right side. The spillway approach channel is separated from the dyke body by a high mountain ridge that provides protection to the dyke during spillway operations. As dictated by the topographic condition, an un-gated ogee spillway is proposed. The crest of the spillway is fixed on the normal conservation level of the reservoir i.e. 1456 m. As the proposed dam is an embankment dam, the proposed spillway has been designed to cater for the 10,000 years return period flood and PMF (with provision of parapet walls).

183. Keeping in view the topography, the low level outlet has been placed on the right side. Its elevation has been fixed on the basis of command area, and sizing of the outlet is finalized

on the basis of irrigation water requirement. Details shall be discussed in the subsequent chapters of the report.

7.2 Planning and Design of Dam

184. The determination of most suitable type of dam and its design is the step that follows the layout planning studies. The Consultants have carried out detailed analysis of all the relevant design parameters to select and design the most appropriate dam section for the project site. The Feasibility Level Design presented in this report have been prepared on the basis of design criteria derived from international practices adopted in Dam Engineering and targeted to provide design solutions for site-specific conditions for project construction and operation. The adopted criteria are in full compliance with International Standards and regulatory documents.

7.2.1 Selection of Type of Dam

185. The selection of type of dam for this site is primarily governed by the foundation conditions and availability of construction materials. The geology and foundation conditions at the dam site usually dictate the type of dam suitable for that site. Competent rock foundations with relatively high shear strength and resistance to erosion and percolation offer few restrictions as to the type of dam that can be built at the site.

186. Geological and Geo-technical Studies (Chapter 6) details the conditions and quality of bedrock, at abutments and dam foundation. At stream bed thickness of alluvium is 8-10 m is anticipated that will be confirmed after geo-investigation. Alluvium consists of gravel and boulders rounded to sub-rounded interfaces filled with fine to medium sand. The narrow river valley and relatively hard foundation makes the selection of a rigid type concrete gravity dam a viable option. However, the abutment rocks are fractured and do not look promising to sustain water pressure of this height of dam. More over materials for the construction of an earthfill dam are readily available in the vicinity of proposed dam site. Accordingly, the best option for dam section at Siri Toi dam site is an earhfill embankment dam.

187. An Earth Core Rock Fill Dam (ECRD) or Earthfill Rock Concrete Dams (ERCD) at Siri Toi site also looks as an viable option where rock material from required excavations and nearby borrow areas can be utilized for embankment construction, however considering clay core earth fill dam construction seems relatively more suitable from the preliminary site visit and geological and geotechnical investigation. The central core earthfill dam has been preferred over the concrete faced rockfill dam (CFRD) for the following reasons:

188. The concrete faced rockfill dam has advantages over central claycore earthfill dam only where earthfill material is not readily available, rainfall is high and extensive grouting is required. These conditions do not exist at Siri Toi dam site. The cost of suitable rockfill in the area is high. Experience with concrete faced rockfill dams (CFRD) in Pakistan has not been good. Only few major concrete face rock fill dams have been constructed in the country. Maximum height of these dams is 40 m. Requisite level of expertise has not been achieved by the local contractors yet. On the other hand numerous claycore earthfill dams have been constructed in the country. Necessary expertise is available with local contractors for constructing this type of dam. Construction materials for central core dam are readily available close to the site. Excavated material from the spillway excavation can be utilized in the embankments. Therefore, earthfill dam with central claycore has been selected as the most appropriate type of dam at the site. The dykes will also be central core earthfill, as the same considerations apply to the dykes as to the main dam.

189. Concrete Faced Rockfill Dam (CFRD) is not suitable for locations where excessive settlements are expected as in Siri Toi because of the deep alluvial overburden. However, detailed analysis and comparison will be carried out after the detailed geotechnical investigation that is in progress on the site.

190. In lieu of Central clay core acting as an impervious layer, the option for considering a membrane of concrete, asphalt, or steel plate on the upstream face as in concrete face rockfill dam has been discarded because sufficient quantity of impervious material is available in the nearby areas for provision of central impervious core. The water tightness of dam foundation can be achieved by taking the earth core down to bedrock.

191. Judicious use of material from excavations such as from spillway and outlet structure will be used as dam fill material in designated embankment zones. The bulk quantities of sandy gravel and sandstone obtained from excavations have been effectively used to provide stabilizing zones on both upstream and downstream shoulders of the embankment dam. Sand available in the riverbed may be utilized as fine filter and gravels which will be used in drainage blankets. The coarse filter, gravel and rip-rap may economically be obtained from nearby borrow areas.

192. After comparing several possible dam locations two axes where analyzed in detail. Option-2 the shorter axis (Length = 231-m and Dyke Length = 234-m) was selected after detailed study and with consideration of the total project cost. Option-1 provided a larger reservoir capacity but the dam length of 993-m increased the cost significantly due to excessive dam fill volume. As the terrain of the area is very steep with narrow valleys across the river bank, the required reservoir capacity is achieved at very high elevations. The required dam height for storage of water required in design command area is 66 m

7.2.2 The Dam Cross Section

193. The cross-sections developed for the embankment dam are based on the essential design requirements for an embankment dam, which are briefly stated as follows:

- The embankment, foundation, and abutments must be stable under all conditions of construction and reservoir operation including seismic forces.
- The upstream face should be properly protected against wave action and downstream face against the action of rain and wind.
- The phreatic line should not emerge at the downstream slope.
- The embankment loading must not overstress the foundation soil and the settlements produced by the loading must not reduce the water retention capability of the dam.
- Seepage through the embankment, foundation, and abutments must be collected and controlled to prevent excessive uplift pressures, piping, sloughing, removal of material by solution, or erosion of material by loss into cracks, joints, and cavities.
- Freeboard must be sufficient to prevent overtopping by waves and include an allowance for the normal settlement of the foundation and embankment as well as for seismic effects where applicable.
- Spillway and outlet capacity must be sufficient to prevent overtopping of the embankment.
- The embankment and foundation must be safe against piping.

- The embankment should be such as to allow optimum use of materials readily available, standard equipment and normal construction control.

7.2.3 Embankment Dam Sections

194. Keeping the above design requirements in view, the embankment dam section has been selected for optimum utilization of natural materials available in the vicinity of the dam site and to represent an integrated design to satisfy seepage, settlement and stability considerations. The available borrow material in the dam area is sandy gravel and clayey silt.

195. A zoned type of earth embankment is proposed with a silty clay core surrounded by sandy gravel fill in the upstream shells. A chimney drain is provided on the downstream contact of core and shell material to intercept any seepage through privileged paths in the embankment fill. The water collected by the chimney drain will be carried through the horizontal drainage blanket and drained through the downstream toe drain. Upstream slope of the embankment is protected with a layer of riprap. The downstream slope of the embankment is to be protected by a layer of stone pitching/downstream slope protection. The foundation seepage is controlled by taking the central core up to the bed rock, forming a key trench.

7.3 Geometric Design of Dam Embankment

Dam Height and Crest

196. The crest of dam shall be at EL. 1462 m which provides a free board allowance of 2.0 m above the maximum reservoir level of EL. 1460 m. The lowest ground level at main dam axis is EL. 1396 m thus the maximum height of dam is 66 m and the dam crest length is 231 m. The axis of the dam was selected keeping in view the topographical features, which provide shortest length of the dam, besides a better tie of the dam with the Right and Left abutments. A 234 m long and about 22 m high saddle dam or dyke with a crest El. 1462-m is also designed to the right of the spillway to close the reservoir rim.

7.3.1 Crest Width

197. Crest width of the dam embankment has been selected on the consideration of ease in construction of embankment, ensuring uninterrupted movement of heavy earthmoving machines through a wide access road. The width has been fixed at 10 m based on the empirical relationship given by USBR (1987).

7.3.2 Embankment Slopes

198. Both upstream and downstream slopes of the embankment have been adopted at 1V:2.5H. The slopes have been designed to be safe for all loading conditions expected during dam construction and its operational life.

7.4 Design Features of Zoned Earth fill Dam

199. Layout plan of the dam is and typical cross section of the zoned earth fill dam is also provided in Volume II of this report. Its design features are given below:

7.4.1 Embankment Zones

200. The embankment has been designed to have following zones:

Central Impervious Zone (Impervious Core)

201. This zone is the main water barrier in the body of dam. It shall be constructed with impervious (permeability less than 1x10-6 cm/sec) sandy/silty clays obtained from river deposits located in reservoir area upstream of dam. The fill shall be compacted to minimum of 98% of the maximum Proctor density at optimum moisture content or slightly on wet side. The top width of this zone has been fixed as 4 m and upstream and downstream slopes at 3V:1H and 4V:1H. The impervious zone will be tied to the bedrock upon excavation.

Down Stream Shell (Shoulders)

202. This zone shall be provided on the downstream side of central impervious core. Pervious material shall be preferred for this zone, which shall be obtained from excavations of structures and from river bed. In case of variation in material from different sources, more pervious material shall be placed towards outer shoulders. Due to possibility of post construction deterioration, use of mudstone from excavation shall not be allowed in this zone. The zone shall be compacted to minimum of 98% of Proctor density.

Drainage Zones

203. The drainage zones consist of 2-layered chimney and horizontal drainage blanket. Each filter layer in the chimney drain shall be 3 m thick and for the horizontal drainage blanket these shall be 0.5 m thick. The fine filter material shall be obtained from river sand while the coarse filter material from crushing and processing of sandstone or river gravels. Engineering properties of construction materials proposed for various zones of embankment are given in Volume – III, Geotechnical Investigation Report.

7.4.2 Upstream Slope Protection

204. Upstream face is protected against wave action by providing a 1 m thick layer of stone rip-rap which shall be placed on 0.60 m thick gravel bedding layer. The design of riprap is based on the criteria given by USBR (1987) and NAVFAC (1982). The design wave height under maximum wind speed of 80 km/hr is estimated as 2.3 ft (0.62 m); against this wave height a rip-rap of nominal thickness of 1 m shall be provided.

7.4.3 Downstream Slope Protection

205. The downstream face of the embankment shall be protected against rain action by providing a 0.6 m thick stone layer.

7.5 Analysis of Dam Embankment

7.5.1 Slope Stability Analysis

206. Appropriate embankment slope adopted after stability has been checked under different loading conditions. The analytical consideration and methods used in the analysis are described below:

Method of Analysis

207. The stability analysis has been carried out by MORGENSTERN-PRICE (1965) method. All the analysis have been done using computer program SLOPE/W. For each case the most critical slip surface has been found by rigorous search on grid pattern.

Section Analyzed

208. The highest embankment section as shown in **Figure 25** is analyzed for stability.

Design Parameters

209. The density and shear strength parameters for the embankment and foundation materials were selected from field and laboratory tests. The values adopted for various materials are given below:

Table 24 - Design Parameters for the Dam Embankment

Material	**Density (kN/m^3)**	**Shear Strength Parameters**	
		Effective Cohesion c' (kN/m2)	**Effective Friction angle (deg.)**
Fill Materials			
1. Impervious Core (Earth Core)	18	15	25
2. Random fill	21.2	15	22
3. Filters	20	5	27
Foundation			
4. River Alluvium	28	30	55

Loading Conditions

210. Stability of embankment slopes has been checked for the following loading conditions:

Upstream Slope

- End of construction.
- Reservoir full at normal pool level, El. 1456 m and steady state pore pressures developed in the embankment and the foundation.
- Complete reservoir drawdown from normal pool level El. 1456 m, without dissipation of pore pressures (rapid drawdown).

Downstream Slope

- End of construction
- Reservoir full at normal pool level, El. 1456 m and steady state pore pressures developed in the embankment and the foundation.

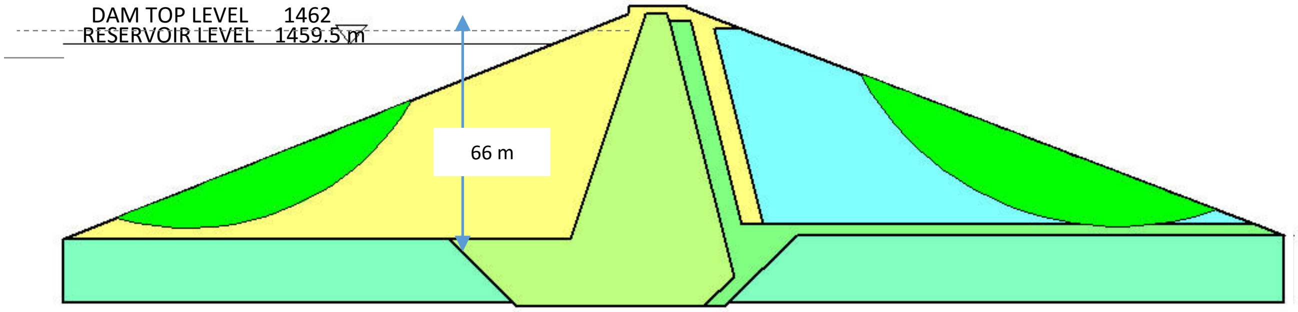
Minimum-Acceptable Safety Factors

211. The embankment slopes have been designed to achieve the minimum values of safety factors as recommended by USACE (1970) as given below.

Stability Analysis Results

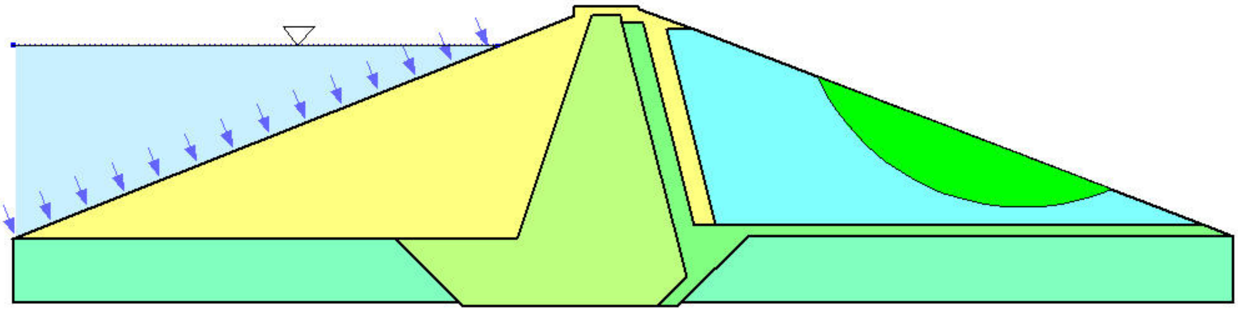
212. The most critical slip surfaces yielding minimum safety factors for various cases analyzed are shown in Figure-24.

End Of Construction



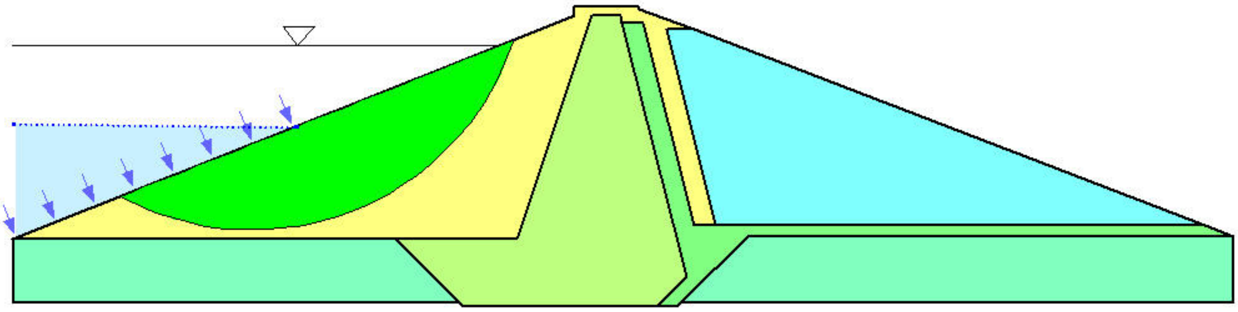
Calculated FOS	
1.87	**1.73**

STEADY-STATE CONDITION



Calculated FOS	
-	**1.79**

RAPID-DRAWDOWN CONDITION



Calculated FOS	
2.08	**-**

Figure 25 - Indicative Resulting Diagrams for Stability Analysis

213. The safety factors found for various loading cases indicated in above diagram are given in Table 25.

Table 25 - Results of Stability Analysis

ANALYSIS CONDITION		SAFETY FACTOR	
		RECOMMENDED	CALCULATED
UPSTREAM SLOPE STABILITY			
1	End of construction	1.30	1.87
2	Rapid Drawdown Condition	1.10	2.08
DOWNSTREAM SLOPE STABILITY			
3	End of Construction	1.30	1.73
4	Steady State Condition	1.50	1.79

7.5.2 Seepage Analysis

Seepage Model and Permeabilities

214. The quantity of seepage flows and resulting seepage forces expected through the body of dam and foundation has been evaluated through finite elements seepage analysis. The analysis has been carried out using computer program SEEP/W (2007). The finite element mesh of the section analyzed is given in Figure 26.

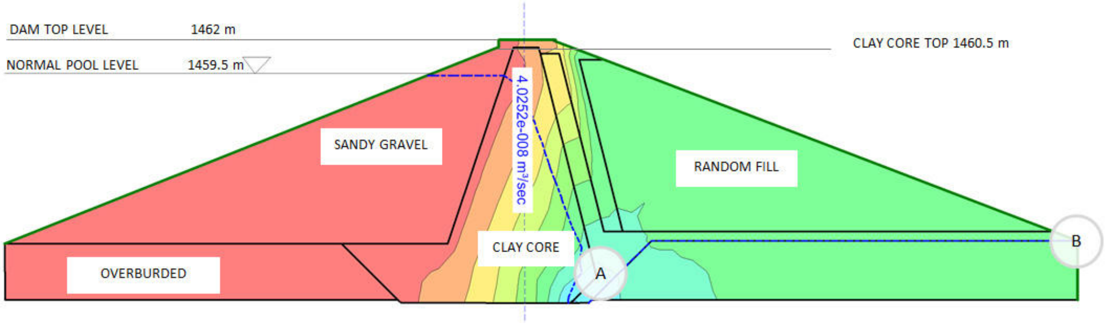


Figure 26 - Indicative Results Diagrams for Seepage Analysis

215. The results of field and laboratory permeability tests have been adopted for modeling different permeability zones. Each case was analyzed for isotropic and anisotropic conditions. The mean permeability values adopted are given in Table 26.

Table 26 - Seepage Parameters

Zone	Means Permeability
1. Clay Fill	1.1 x 10-9
2. Sandy gravel	1.0 x 10-5
3. Random fill	1.18 x 10-5
4. Foundation	1.0 x 10-8
5. Filter	Free Draining
6. Grout Curtain	1.18 x 10^{-3}

216. The preliminary seepage analysis results are given in Table 27.

Table 27 - Results of Seepage Analysis

PARAMETERS	VALUES
Exit Gradient at Toe of Dam (B)	8.2 x 10-3
Exit Gradient at Toe of Core (A)	8.6 x 10-1
Velocity at Toe of Core (A) (m/s)	3.1 x 10-9
Velocity at Toe of Dam (B) (m/s)	2.3 x 10-10
Total Discharge through Dam body and Foundation (cumec)	4.0 x 10-8

7.5.3 Seepage Control and Disposal System

Control of seepage through body of Dam

217. Seepage through body of dam shall be controlled by central impervious zone which shall have permeability ranging between 10-6 to 10-8 cm/sec. However for a safe discharge of seepage an inclined chimney drain is provided against the downstream face of the impervious zone.

218. The chimney drain shall be laid in two layers, i.e. the fine filter layer will be flanked by coarse filter layer and the downstream random fill. The gradation of chimney drain filters has been designed so as to meet filter criteria for impervious zone, downstream random fill and adjacent layers. The chimney drain shall not only dispose of the seeping water but shall also guard against movement of soil particles from the impervious zone and along concentrated leaks resulting from defective construction, high anisotropy with respect to permeability or presence of undetected pervious layers within the impervious zone.

Assumptions for Dam Design

219. The geotechnical investigation for the Siri Toi dam site could not be started due to flood and other reasons at the site during the recent months. Therefore the design of the dam is based on the Consultants judgments and experience about sub-surface conditions in similar dam projects in Balochistan. After the completion of geotechnical investigation works during coming months if the soil/rock properties are significantly different from our expected values the dam design will be modified accordingly.

Treatment of Foundation rock for Seepage Control

220. Following measures are proposed to control the seepage or reduce seepage forces along the dam foundation and safe disposal of seepage.

a) The embankment core shall be taken to sound rock.
b) The exposed foundation rock along the core trench shall be dental treated and a relatively soft clay layer shall be placed in contact with rock before the placement of normal core material.
c) Up to 30-40 m deep grout holes at 3 m c/c may be provided under the earth core grouting plan to be designed).
d) A horizontal drainage blanket, consisting of fine and coarse filter layers shall be placed from chimney drain to the downstream toe of the dam. The drainage blanket shall collect seepage water from foundation and chimney drain for disposal into toe drain. The filter layers will prevent migration of fines from foundation, which can otherwise develop into concentrated leaks and piping mechanism.
e) A toe drain shall be provided at the downstream toe of the dam from where the water shall be diverted into discharge measurement flume at two or three collector points and will be disposed of into the river.

221. After confirmation of depth of bed rock in dam foundation during geotechnical investigation (drilling) after flood season suitable type of seepage control method will be finalized as indicated above from a) to d).

7.6 Design of Spillway

222. Considering the hydrological conditions of Balochistan where flash floods are frequent, an uncontrolled (ungated) ogee crest spillway has been proposed. An Ogee spillway has a crest geometry that conforms to the lower nappe of the water profile. For the design discharge, water glides over the crest with minimum frictional losses along the concrete surface providing maximum discharge efficiency. The upstream end of the crest is joined with the approach channel by a 1 V: 1 H sloping face. The downstream end of the crest connects to a 1V:4 H steep spillway chute. The lower part of the chute connects to a termination structure (USBR Type II Basin) before entering the river.

223. The Siri Toi spillway is designed for a 10,000 year return period flood (2,158 cumec). The design head is 3.6-m with a crest length of 135-m. The spillway crest level is set at a level of 1456-m above m.a.s.l. The rating curve of the spillway is given in Figure 4.

224. Similarly to ensure dam safety and climate change vulnerability flood routing for PMF (4,946 cumecs) is also carried out.

7.6.1 Design of Spillway Profile

225. The spillway profile comprises of the ogee crest and the chute portion. The ogee crest design is based on the lower nappe profile of water at design discharge. The chute slope is decided considering minimum cut and fill volumes along the spillway alignment and after computing flow depths along the chute. The final shape of the ogee crest is based on the design head

7.6.2 Energy Dissipation

226. In order to attenuate the erosive energy and velocity of the outflowing water from the dam and to return water to the river in a tranquil state, a USBR Type II stilling basin is provided. The design procedure explained in “USBR EM 25 Hydraulic Design of Energy Dissipators and Stilling Basins by A.J.Peterka” is followed to finalize the dimensions and level of the basin. The energy dissipator is provided immediately downstream of the 1V: 4H chute that is designed based on the natural terrain and flow hydraulics of the spillway.

7.6.3 Sluices

227. Sluicing or Flood Flushing could be an effective option for reducing reservoir sedimentation. ICOLD Bulletin Sedimentation and sustainable use of reservoirs and river systems (2009) has analyzed several dams around the world and plotted a graph indicating the suitability of sluicing or food flushing based on capacity to inflow ratio. ICOLD suggests that the best efficiency of sluicing is achieved if the reservoir storage is less than 5 % of the annual average inflow. However, as Siri Toi annual inflow is not in excess of its capacity, sluicing or flood flushing is not possible for this reservoir. As an alternative, check dams and other watershed management practices are planned to minimize the sediment yield and maximize the life of the reservoir.

7.6.4 Intake Structure

228. The outlet works for Siri Toi Dam consist of a multi-level inclined intake structure. The intake structure is located on the upstream embankment slope on the right abutment side. The intake structure has three shafts with entrance levels at El. 1410, 1420 and 1430-m. Each shaft has a bell mouthed inlet on top ensuring streamlined and turbulence free entrance of water into the intake structure. The multi-level intake allows withdrawal of water at different reservoir levels with consideration for reservoir siltation during the dam life. Slide gate at the entrance of each intake shaft is provided. All three gates will operate under balanced head conditions either fully open or fully closed.

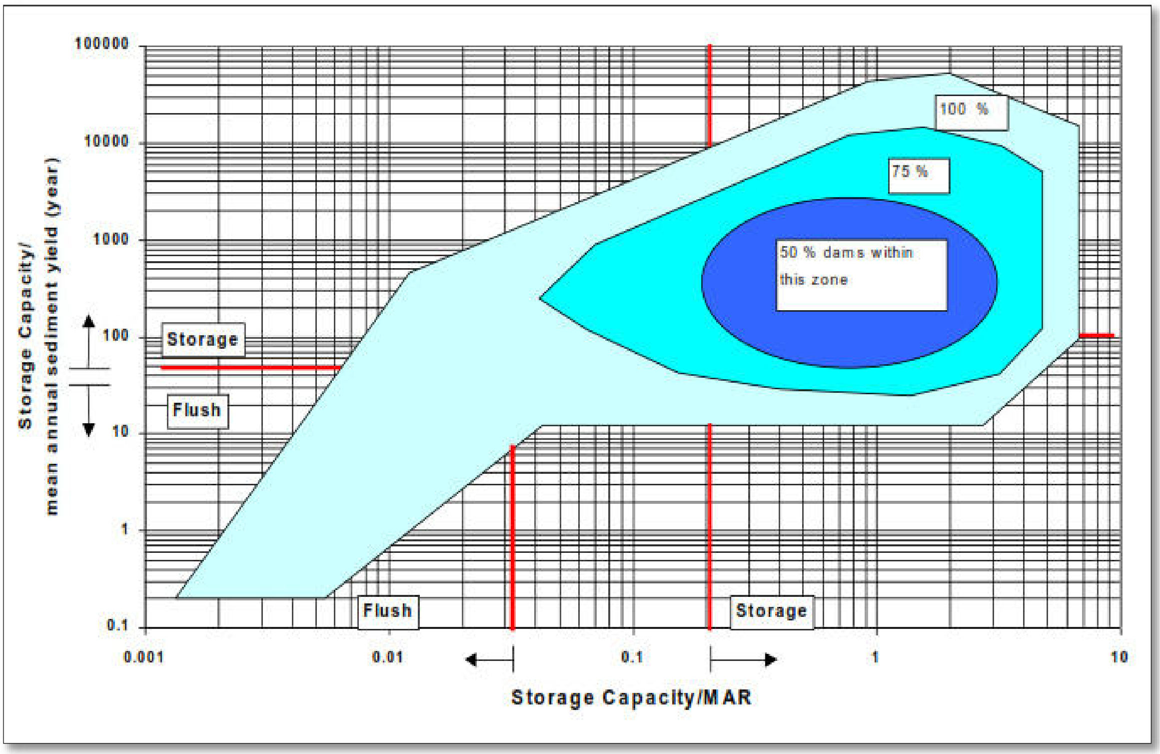


Figure 27 - Empirical Reservoir Classification Based on Storage, Runoff and Sediment Yield (ICOLD Bulletin, 2009)

229. A single sliding trash rack is provided that will be moved on the entrance of the intake shaft being used. An operating deck is provided on the crest of the dam for operation of the slide gates and trash rack. The shaft and horizontal conduit have a square cross-section (1-m x 1-m). The multi-level inclined intake structure connects to a 1-m diameter steel pipe embedded in concrete. The cut-and-cover arrangement outlet system passes through the dam body. A hollow jet valve is provided for flow regulation. It will regulate the monthly variation in releases throughout the year. The control valve is located at the end of the outlet system terminating into an energy dissipater. This arrangement subjects the whole outlet system to internal pressures equivalent to the reservoir head and categorizes the outlet system as a downstream control configuration.

7.6.5 Outlet Conduit and Steel Pipe

230. The three intake shafts connect to a 1-m x 1-m reinforced concrete square conduit that provides a supporting base and connection to the multi-level intake structure. Downstream of the RC conduit a 1-m steel pipe is connected forming a transition, the hydraulic radius of both conduit and steel pipe is 0.25-m. The steel pipe losses analyzed show that the system is appropriate for delivering the design discharge even at lower heads. Furthermore, it is large enough to allow safe drawdown of reservoir in case of emergency or reservoir emptying.

7.6.6 Losses in the Outlet system

231. As water flows through the outlet system each component produces some losses against the available head in the reservoir. The dimensions, geometry and appropriateness of each component are reviewed to assure safe hydraulic performance as recommended by various hydraulic design codes and practices (USBR, USACE and FEMA etc.). The sizes and

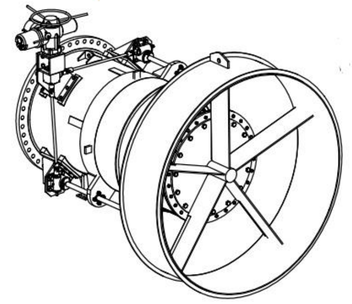
corresponding losses of all components in the system have been reviewed for adequacy of delivering the design discharge of 3 cumecs at reservoir levels ranging from 1410 and higher.

7.6.7 Flow Control Valve

a) Selection of Valve type

232. Advanced Dam Engineering (1989) recommends the following valves as flow control:

- Needle valves
- Hollow jet valves
- Fixed cone valves



233. A Hollow Jet valve (fixed-cone with hood) has been selected for controlling the releases from Siri Toi Dam. The streamlined shape of this valve will ensure proper functioning and flow control at partial openings [4].

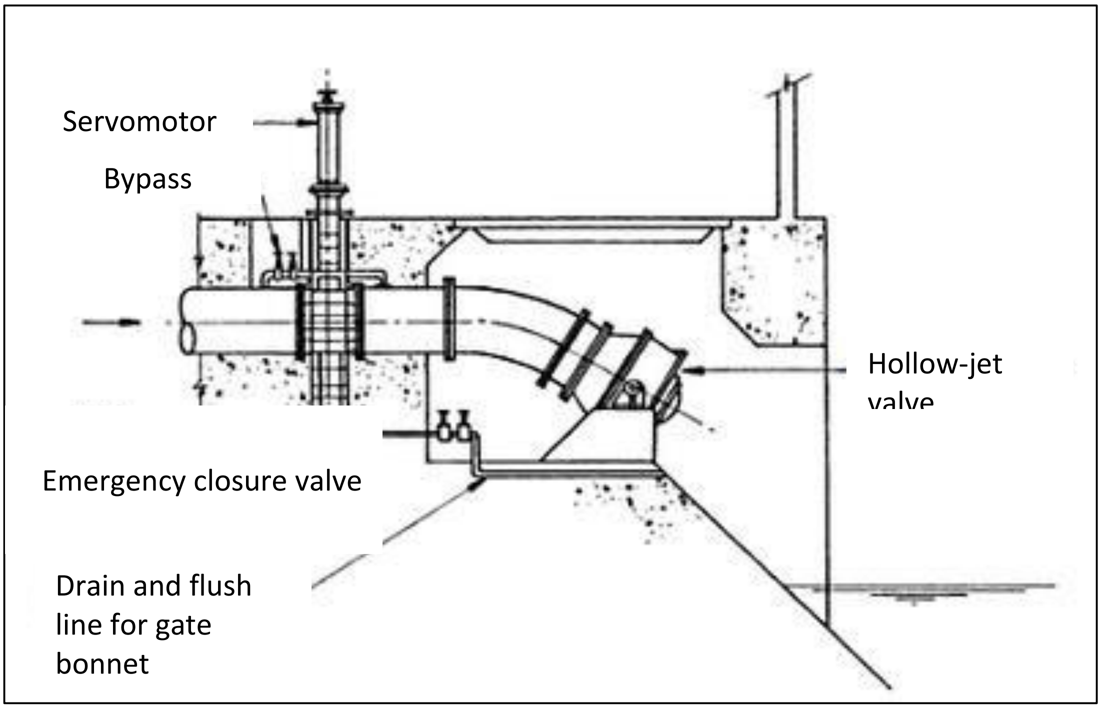
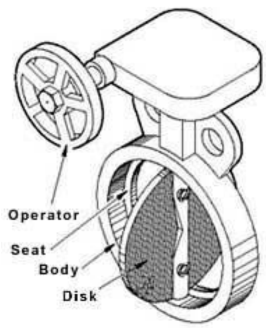


Figure 28 - Hollow jet valve arrangement

b) Emergency closure valve

234. The emergency valve (butterfly valve) is provided upstream of the flow control (hollow jet valve) valve for emergency closures. The butterfly valve will not be used for flow regulation since the design head, 64 m, which is much higher than the head of 15-m at which butterfly valve can be used as regulating valves [2].



c) Diameter

235. The valve diameter has been sized to release the required discharge at low heads. A series of trial diameters were checked. For each trial diameter, the discharges for both high and low heads are calculated; considering losses in the system.

236. The discharge is calculated using the Orifice formula:

$$Q = CA\sqrt{2gH}$$

where,
C = coefficient of discharge (0.7)
A = cross sectional area of flow through valve, $\mathrm{A} = 0.25\pi\mathrm{d}^2$ (m^2)
H = available head (m)
g = acceleration due to gravity, (m/s^2)

237. The head at Maximum conservation level, 1456-m, is the high head; while the low head is measured from the lowest intake level, intake-1,1410 m. The valve elevation is 1402 m. Total losses, can been approximated as the sum of all the frictional losses in the system:

$$h_f = \frac{29.1n^2v^2L}{2gR^{4/3}}\ [ft]$$

where,
h_f = frictional losses (ft)
n = roughness coefficient (0.008-0.012 for steel)
L = length of pipe (ft)
R = hydraulic radius (ft)

238. The 1-m diameter steel pipe is nearly 1650-m long. A 0.8-m diameter valve has been selected, which is capable of releasing discharge of around 2.8 cumec at the minimum head of 8-m (reservoir level 1410 m), and nearly 7.3 cumec at maximum head of 54-m (reservoir level 1456-m).

7.7 Outlet Stilling Basins

239. An energy dissipater is provided immediately downstream of the control valve. This ensures that the water releasing from the outlet enters the tailrace channel without erosive velocities at all operating discharges. The Geometry and dimensions of the stilling basin are based on the design procedure explained in “USBR Hydraulic Design of Stilling Basins and Energy Dissipator by A.J.Peterka”. A USBR Type VIII basin is being proposed. This type is recommended for use with hollow jet valve, where the releasing jet plunges into a lowered basin. The proposed dissipater is designed for a 3 cumecs discharge (106 cusecs).

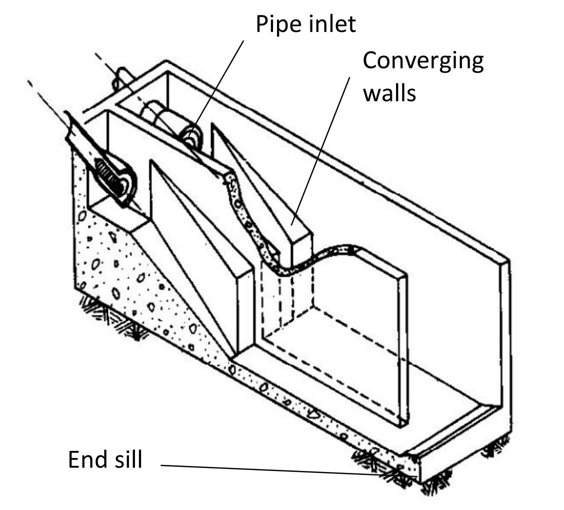


Figure 29 - USBR type VIII basin (proposed stilling basin)

7.8 Flow in Tailrace Channel

240. The flow depths in tailrace channel located immediately downstream of the control valve act as tail water elevations for the energy dissipater. These tail water depths must be within defined ranges to assure proper functioning of the energy dissipater. The normal depths against various incoming discharges for the tailrace channel have been computed. The elevation and dimensions of various components of the energy dissipater have been fixed to optimally harmonize with the computed tailrace water levels for efficient performance.

7.9 Steel Pipe Supports and Anchor Blocks

241. The outlet steel pipe exposed above the ground level is supported by ring girders with fixed and moveable joints. Moveable joints allow release of thermal stresses induced by temperature variation. To provide pipe support on steep slopes and bends, anchor blocks and/or thrust blocks are provided. The design of pier supports/ring girders is based on the combined weight of water and pipe, while the thrust blocks resist the forces exerted by water changing direction.

7.10 Irrigation System

7.10.1 General

242. The proposed Irrigation Canal System comprises about 156 km long canals of which the main canal is 43.88 km long. The proposed system has been designed to meet irrigation water requirements of the Command Area. Figure 30 shows the proposed canal system.

7.10.2 Hydraulic Design Criteria for Canals

The crop water requirements for the proposed cropping pattern for the command areas has been computed and details are indicated in chapter 5 (Agriculture) of this report. The Irrigation demand thus established is used to workout design capacities of main canal and distributaries. Detailed survey of the command area has been carried out to establish command area levels. The channel bed slope is selected keeping in view ground slope. Manning's equation has been used to workout canal section at various locations. Manning's formula is expressed as follows:

$$V = \frac{1}{n}(R)^{2/3}(S)^{1/2}$$

and $Q = AV$

Where:

Q	=	the discharge [m^3/s]
A	=	the area of flow [m^2]
S_f	=	the slope of the energy line
R	=	the hydraulic radius = A/P [m]
P	=	the wetted perimeter of the flow [m]
n	=	Manning's roughness coefficient

243. Since the canals are concrete lined value of Manning's roughness coefficient "n" has been adopted as 0.016. The consultants have developed software for the design of canal system using Manning's equation. The iterative process in the equation has been solved in the model with design results based on adopted criteria.

7.10.3 The Design Methods

244. An automatic process is adopted for the design of distribution System. Different modules of Eagle Point's software were used for this purpose. For instance, the strip topo survey data has been transferred into CAD format using the Survey transfer module. Based on its surface model/ contour map is prepared using the Surface modeling module and the alignment has been imposed on it. The in-house developed canal design software helped the design engineer to properly and efficiently design the cross and long sections of the canal based on defined criteria and field conditions. The output of canal design software was transferred to "Road Calc Module" for automatic longitudinal and X section generation in AutoCAD. The module also calculates quantities of earthwork (cut and fill) and concrete for the given cross and longitudinal sections.

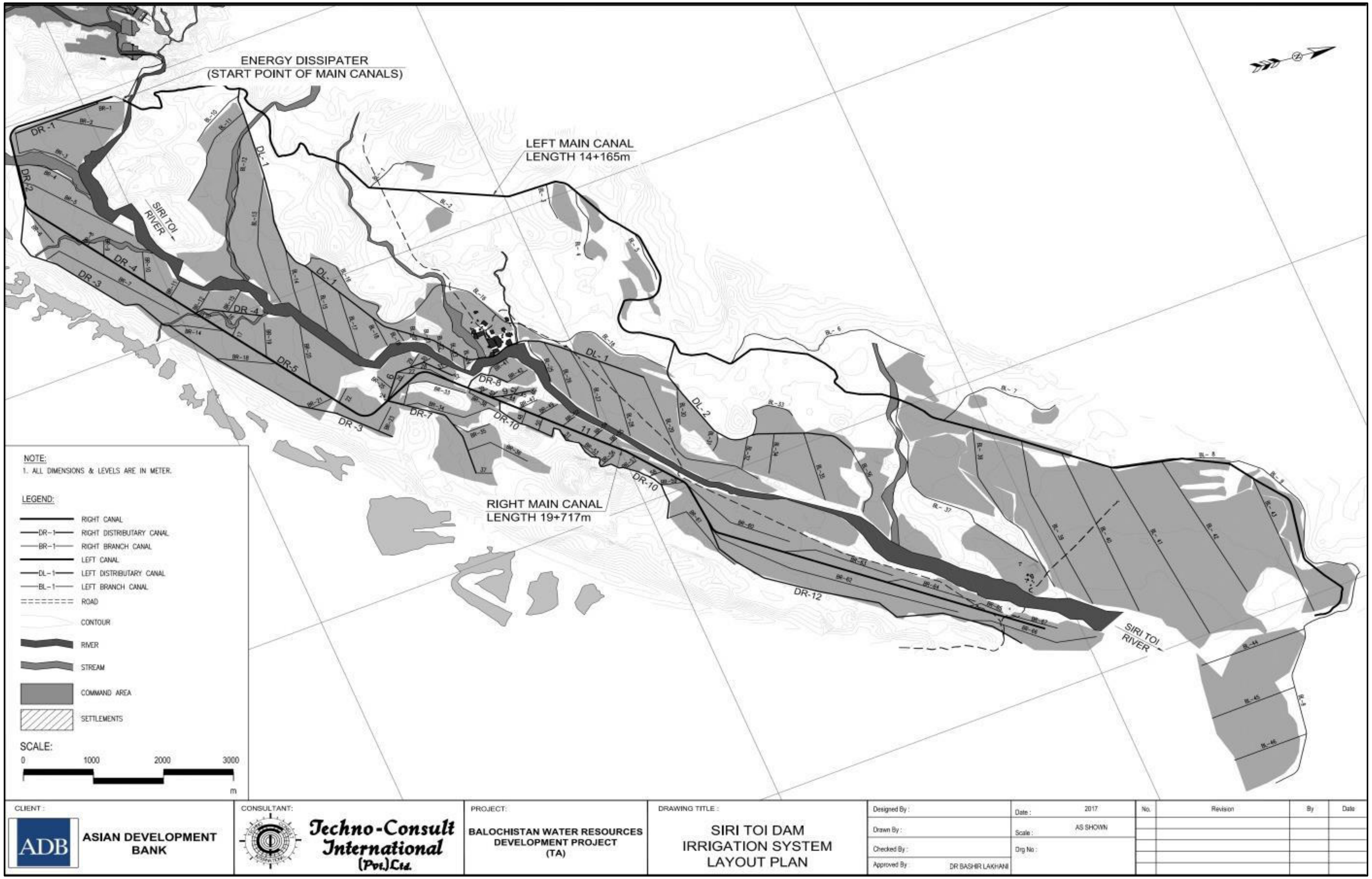


Figure 30 – Layout Plan of Irrigation Network

7.10.4 Canal Structures

245. Releases from the reservoir through outlet structure will be carried to the command area through main and branch canals. The canal sections have been designed for design flow gradually reducing with each off-take. A number of structures are proposed on each canal including drop structures, aqueducts, road crossings, off-take structures and river crossing. The flow division structures have also been designed at appropriate locations taking into consideration the following criteria.

- The size of the openings is adjusted to be proportional to the water rights allocated to each of the downstream channels.
- Flow over through the fall on every opening must be free flowing (i.e. flow must not become submerged by the downstream water level backing up. For this reason it is recommended that the drop across the fall for these small structures should be at least 150mm (6 inches).
- The incoming velocity immediately upstream of the outlets should be less than 1 m/s (3 ft/s).

246. The water depth over the weir of any division structure is effectively governed by the height of the incoming channel banks. A list of canals in the irrigation system along with number of structures are summarized in the Table 25.

Table 28 - Conveyance System

	Design Capacity (cumec)		**Length (km)**		
Structure	**Left**	**Right**	**Left**	**Right**	**Total**
Main Canal	2.00	1.50	24	20	44
Distribution Canals	0.3-0.5	0.1-0.2	12	20	32
Branch Canals	-	-	40	40	80
Total			**76**	**80**	**156**
Cross Drainage Structures					
Structure			**Left (No.)**	**Right (No.)**	**Total (No.)**
Drop Structure (Fall)			54	44	98
Aqueduct			6	3	9
Culvert			4	4	8
Syphon			3	-	3
Off-Take			20	11	31
Cattle Drinking			3	2	5
Washing			3	2	5

8 SOCIO ECONOMIC PROFILES

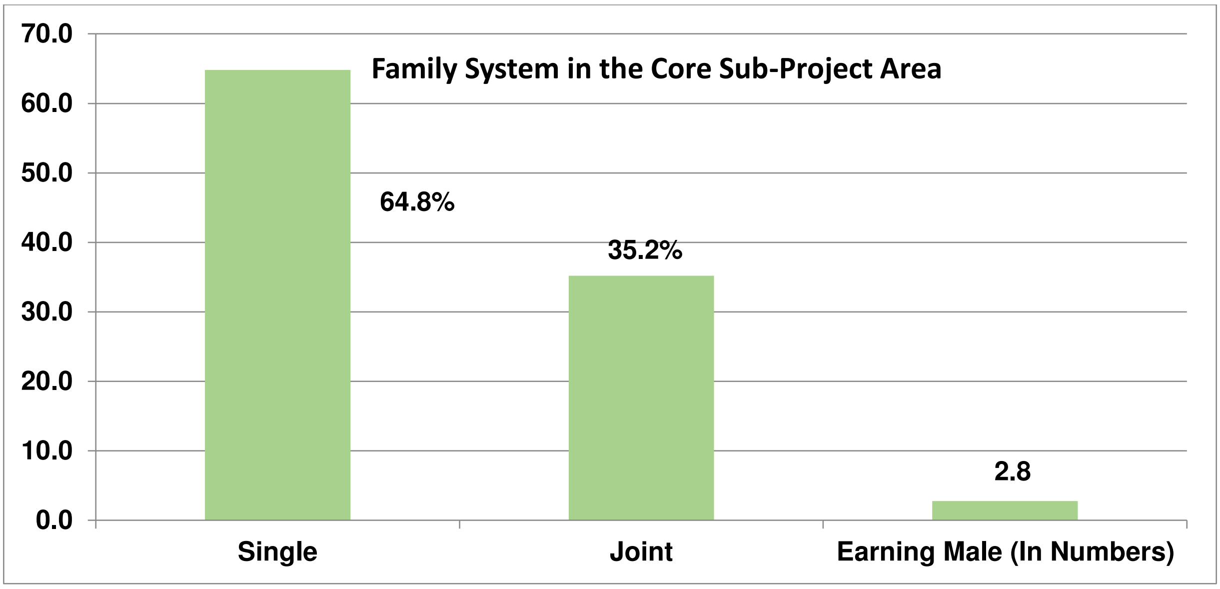
8.1 Population and Community Structure

247. The main tribe living in the sub-project area belongs to the Arbzai clan of Mandokhail, list of the main villages are given in Table 29. These are ultimate beneficiaries of the project. Pushto is spoken as the major language in the area while small number of the people can speak Urdu. The communities belong to Muslim religion group. The demographic information of the sub-project is detailed in the following Table 29;

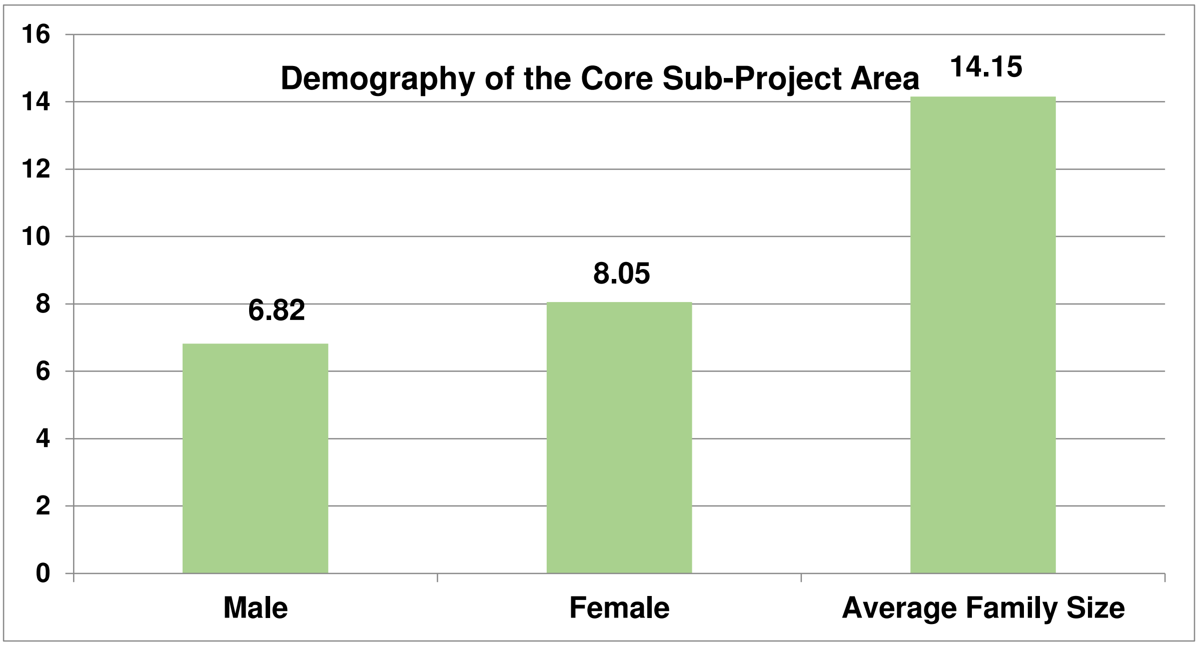
Table 29 - Name of villages, total households and population in Siri Toi water storage dam irrigation Core-Sub-project

Name of Scheme	No	Village Names	No of Water /Landholding Households	Population	Male	Female
Siri Toi Dam	1	Tora Darga	262	2725	1219	1506
	2	Killi Hazrat Sahib	48	2251	1070	1181
	3	Killi Surghundi	36	273	121	152
	4	**Killi Nave Oba**	75	548	230	318
	5	Killi Bobi Irrabzai	85	618	267	351
	6	Killi Ashai Kasi/Fakhri	15	87	39	48
	7	Killi Omvani Shpa	17	139	62	77
	8	Killi Gada Khel	61	1926	893	1033
	9	Killi Zawai	20	546	268	278
	10	Killi Tor Ghundi	37	559	277	282
	11	Killi Sunkasi	48	894	423	471
	12	Killi Rodh Ahmadkhel	33	595	283	312
	13	Killi Doshana Hazrat Sahib	20	228	109	119
	14	Killi Landi Bobi	45	658	297	361
	15	Killi Loi Mina	29	347	156	191
	16	Killi Shahwaz	10	129	64	65
	17	Killi Qatal Khan	23	388	172	216
Total			**864**	**12911**	**5950**	**6961**

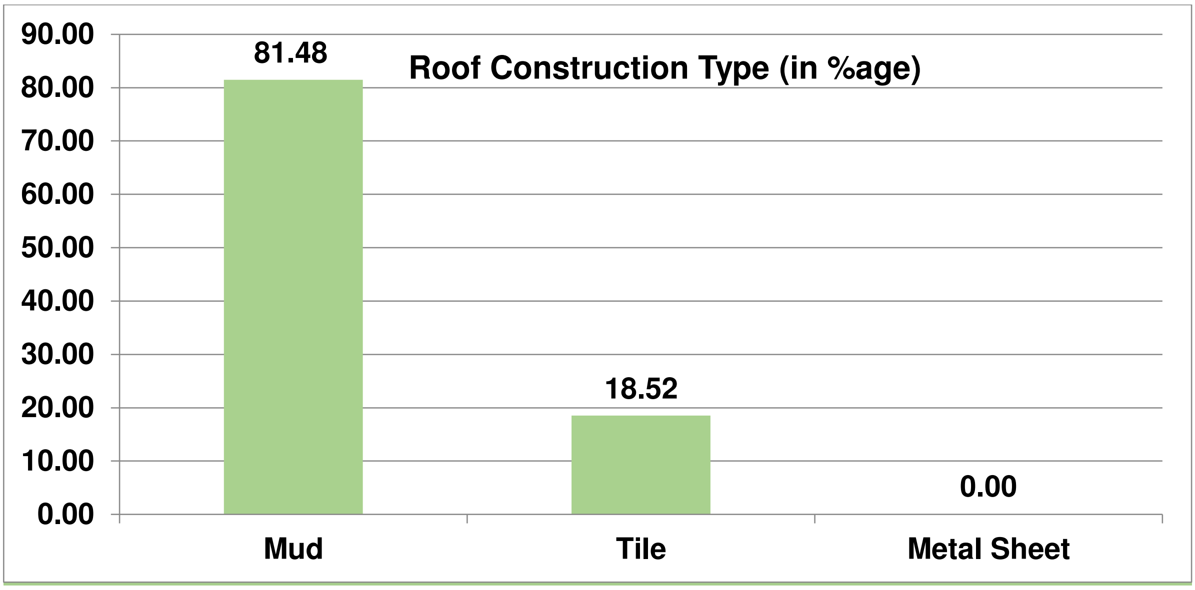
248. As indicated in the following graphs, the family system in the project area is 64.8% nuclear family system, 35.2% is living in joint family system and the average earning male family members are reported 2.8%. The average family size is 14.15, male and female ratio is 6.82 and 8.05 respectively.



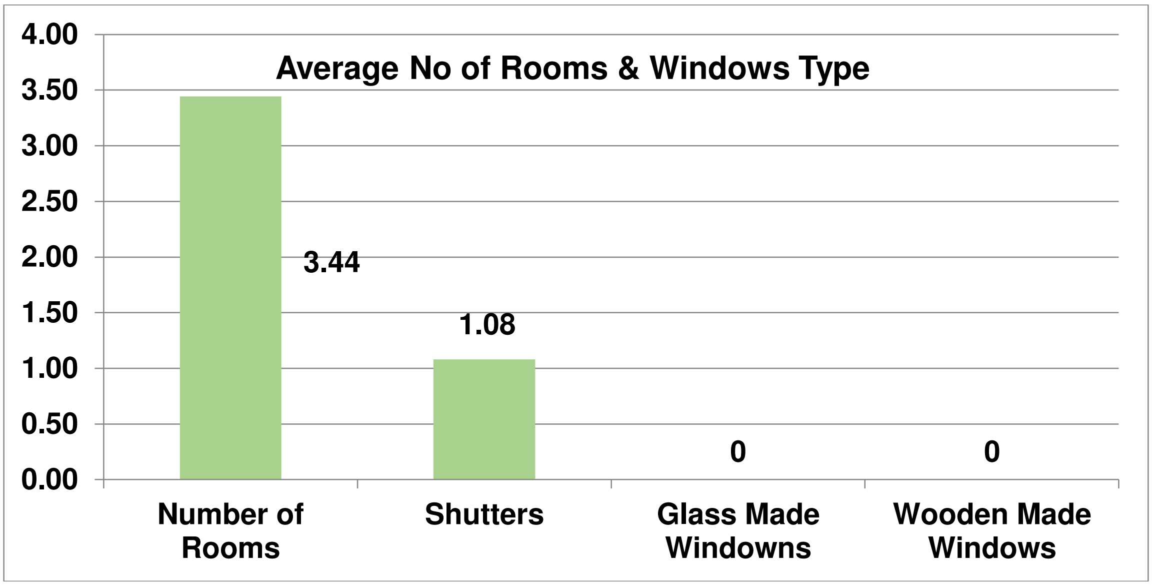
8.2 Houses Construction Type



249. The project area is consisting of rural population lives in compacted clusters. Majority of the population live in small settlements of five to twenty houses scattered all over the project area. In the project area, 100% of the houses are made of stone masonry and built without layout or plan and without any regard to blocks. All mud houses usually have a boundary wall enclosing enough space for cattle and storage. The roof of a mud house consists of 81.18% muddy and 18.52% are composed of tiles.

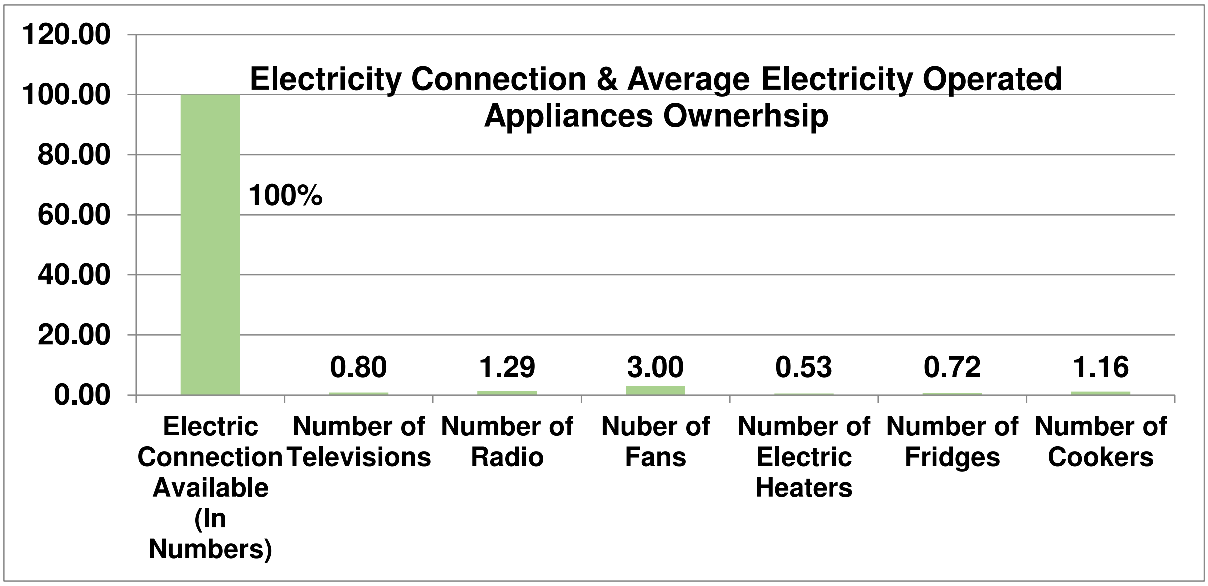


250. The following graph portrays the average number of rooms owned by the residents is 3.44 and shutters for the houses bound in a single compound is 1.08.



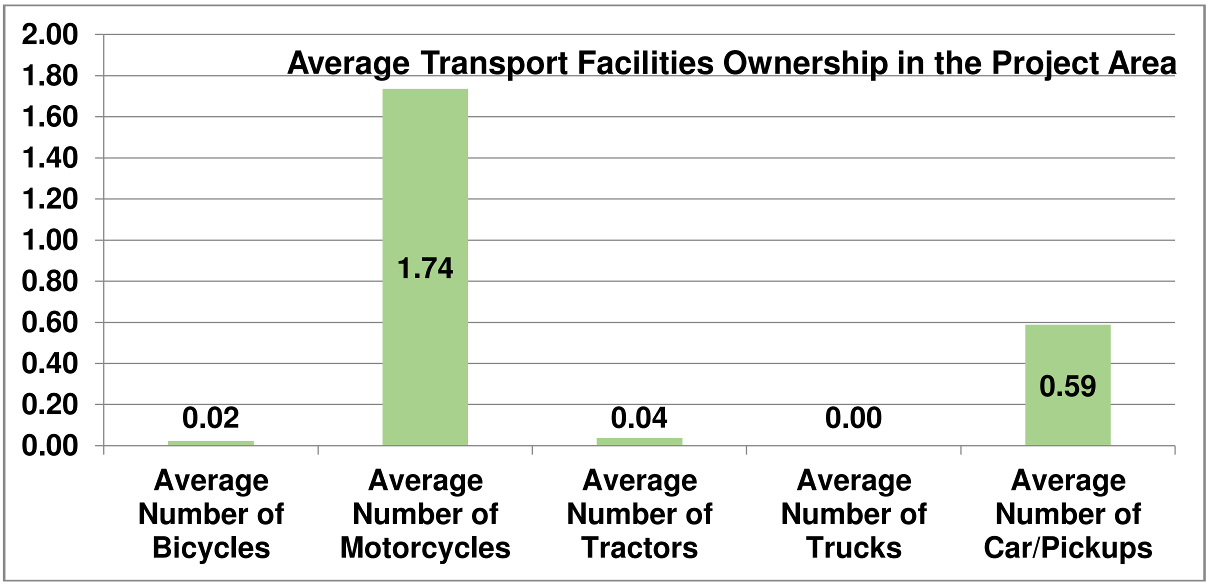
8.3 Electricity Connection & Electricity Appliance Ownership

251. The survey data reveals that the overall villages falling in the command of the proposed Siri Toi Dam Project are electrified. The electricity appliances average ownership in the project corridor are television 0.80, radio 1.29, fans 3.0, electric heaters 0.53, fridges 0.72 and cookers are 1.16.



8.4 Transport Facilities in the Project Area

252. Most of surveyed villages in the project area have village tracks or un-surfaced (Kacha) roads and are linked with Zhob city through Simbaza Zhob black top road. The condition of Kacha village road is almost in good condition. As portrayed in the following graph, the major source of the human transport is motorcycles which are averagely owned by households 1.74, bicycles 0.02, pickups 0.59 and tractors ownership is 0.59.



8.5 Religious and Cultural Values

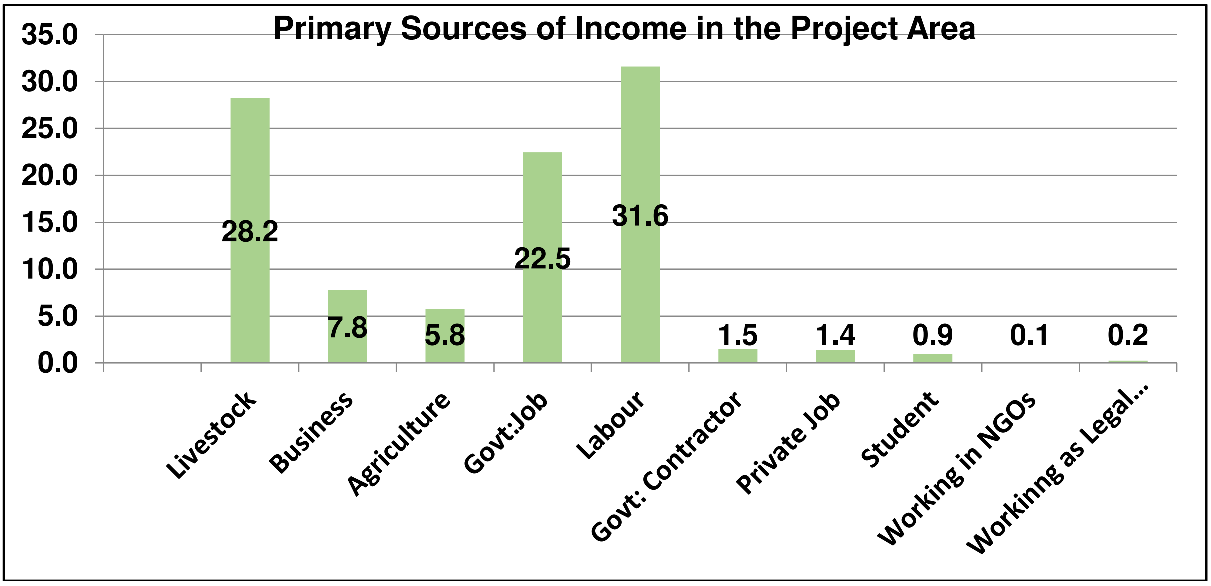
253. The majority of the population in the project area is Muslims. The majority of the population is Deobandi sect of Suni. Their religious leader has many codes of honor like Mulla

and Pir. Mullah performs Nikah, leads Eid and Juma prayers and at the time of a burial leads funeral prayer (Janaza) besides leading five times a day congregational prayers. Important religious events are Edi-ul-Fitur, Eid-ul-Zuha, Eid-Miladun Nabi and Mohrum.

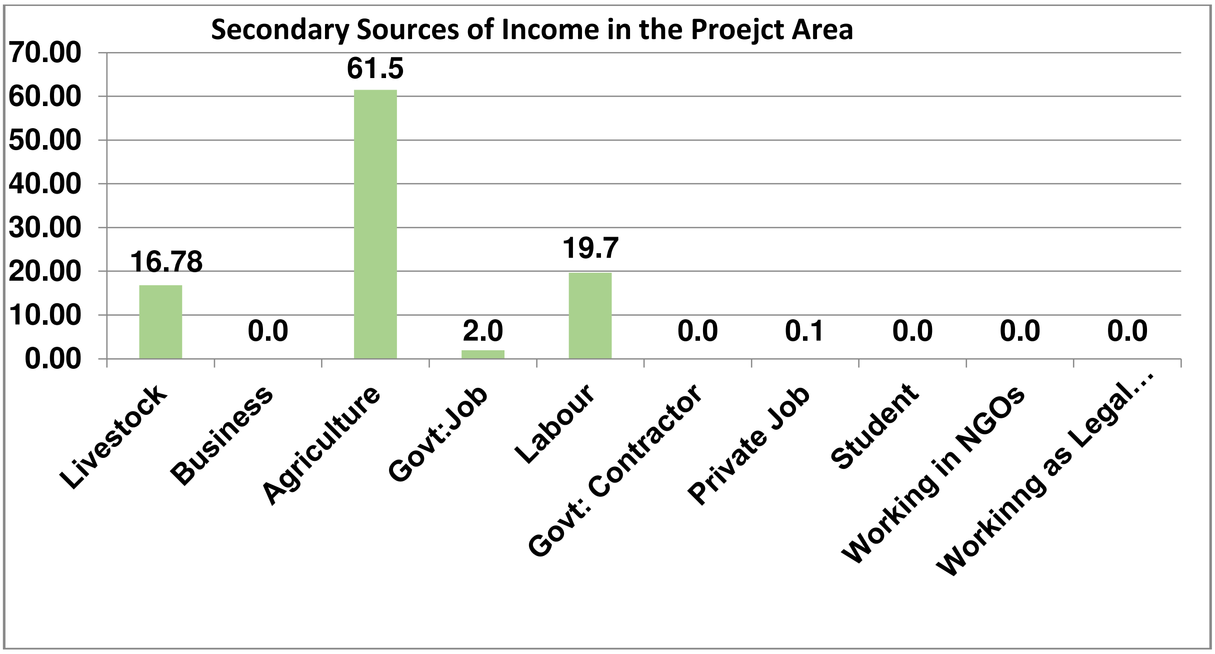
8.6 Socio Economic Status

8.6.1 Sources of Income

254. The integrated survey conducted in the sub-project and portrayed in the following graph reveals that wage laboring is the highest primary source of income for 31.6% households; livestock rearing is the source of income for 28.2% households, government employment is third major source of income for 22.5% of the households. The remaining primary sources of income are small businesses, agriculture, working as government contractor and working as legal consultant and with the NGOs.

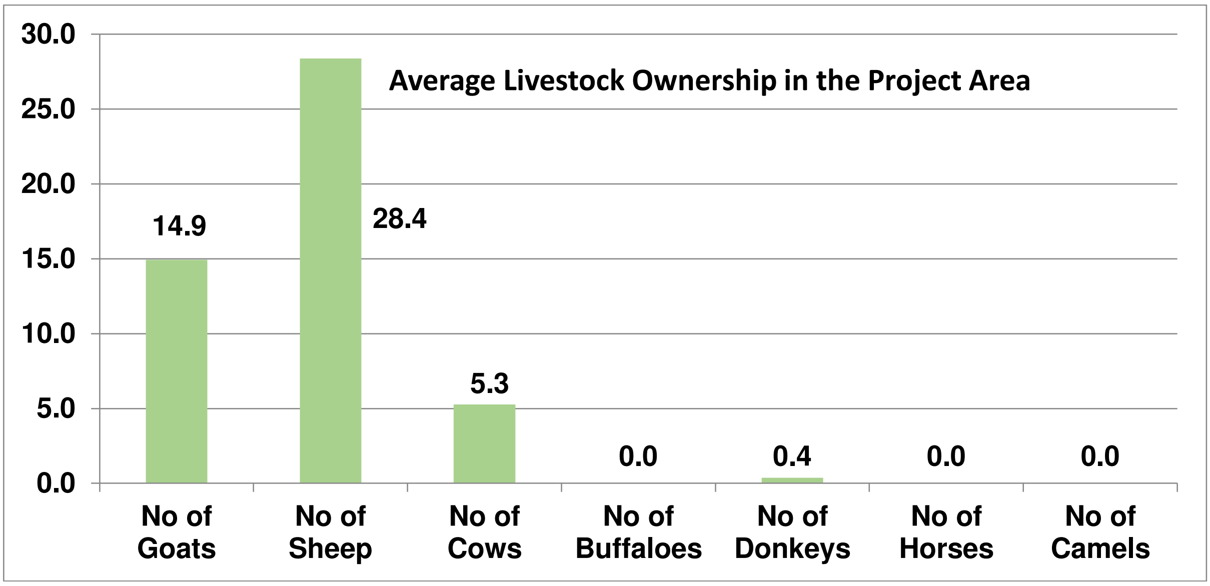


255. As indicated in the following graph, agriculture is the largest secondary source of income for 61.5% households beyond the command of the proposed Siri Toi Dam, wage laboring is the second largest secondary source of income for 19.7% households and livestock rearing is the third largest secondary source of income for 16.78% households. The remaining secondary source of income is the government employment.

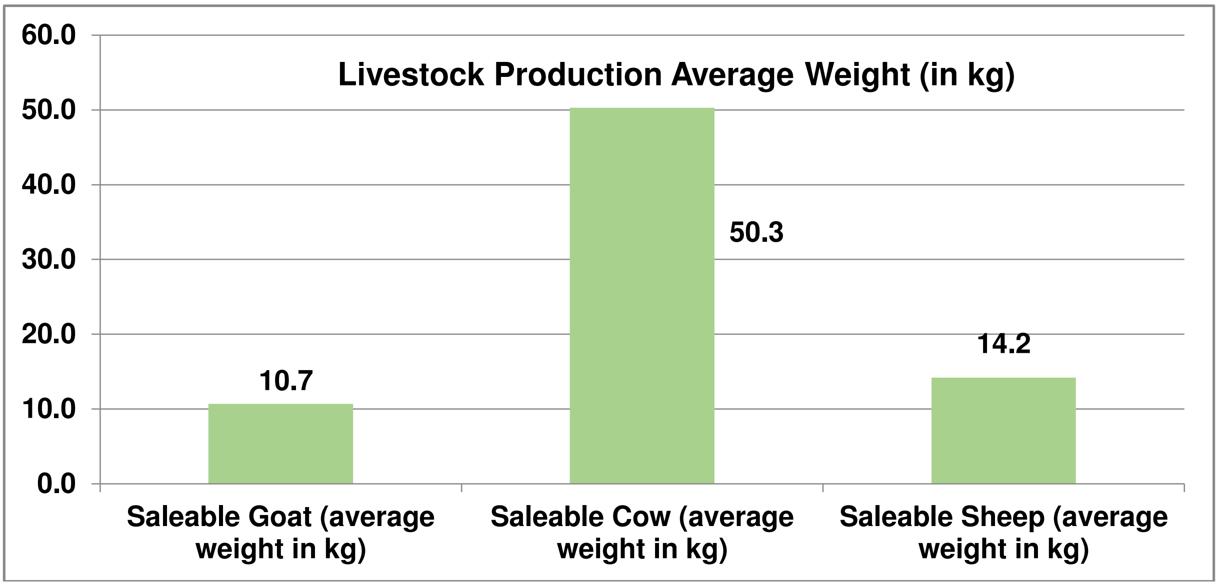


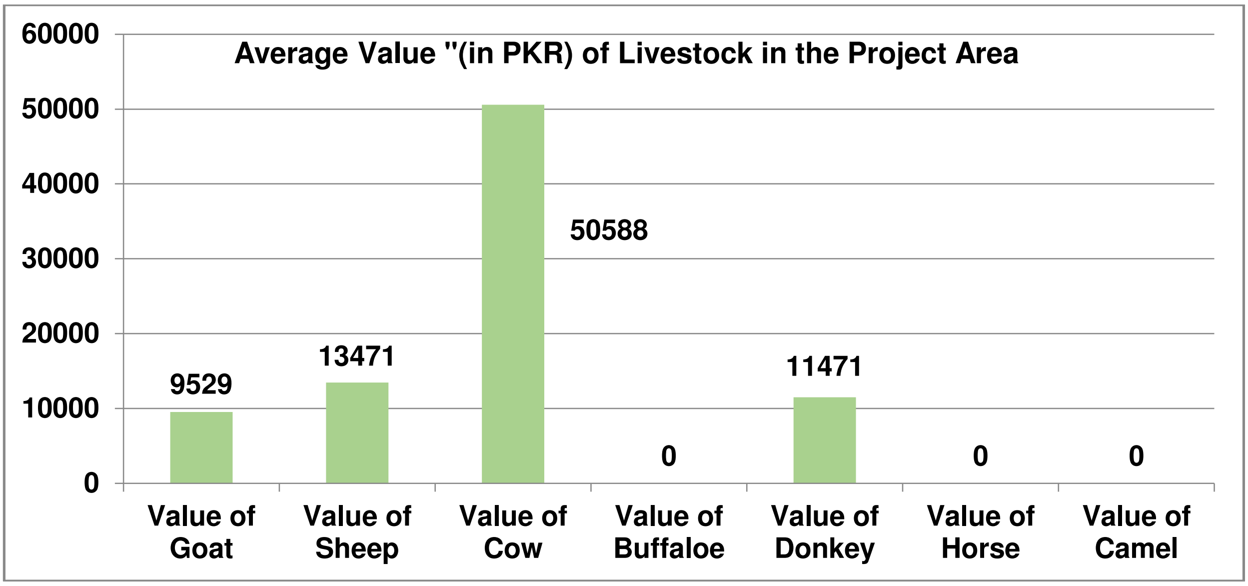
8.6.2 Livestock in the Project Area

256. Livestock is one of the allied fields of agriculture. The project area has following types of livestock as portrayed in the graphs with its average ownership per household.



257. The above graph reveals that, the highest reported population among all the sheep and goats are averagely owned per household 28.4 and 14.9 respectively. This shows that sheeps and goats are the preferred farm animals that people like to keep and grow as compared to any other livestock species probably due to the suitable weather conditions and the ease of keeping it. The other ruminants are cows and donkeys in the project area. The donkeys are also in the area used for fetching water and woods from the mountains. The livestock meat production is illustrated in the following graph which indicates that the average weight of goat is 10.7kg, meat production of cow 50.3kg and average weight of sheep is 14.2kg.





258. The above graph is indicating the average value of livestock where the value of goat is Rs. 9,529, value of sheep is Rs.13,471 value of cow is Rs. 50,588 and value of donkey is Rs.11,471.

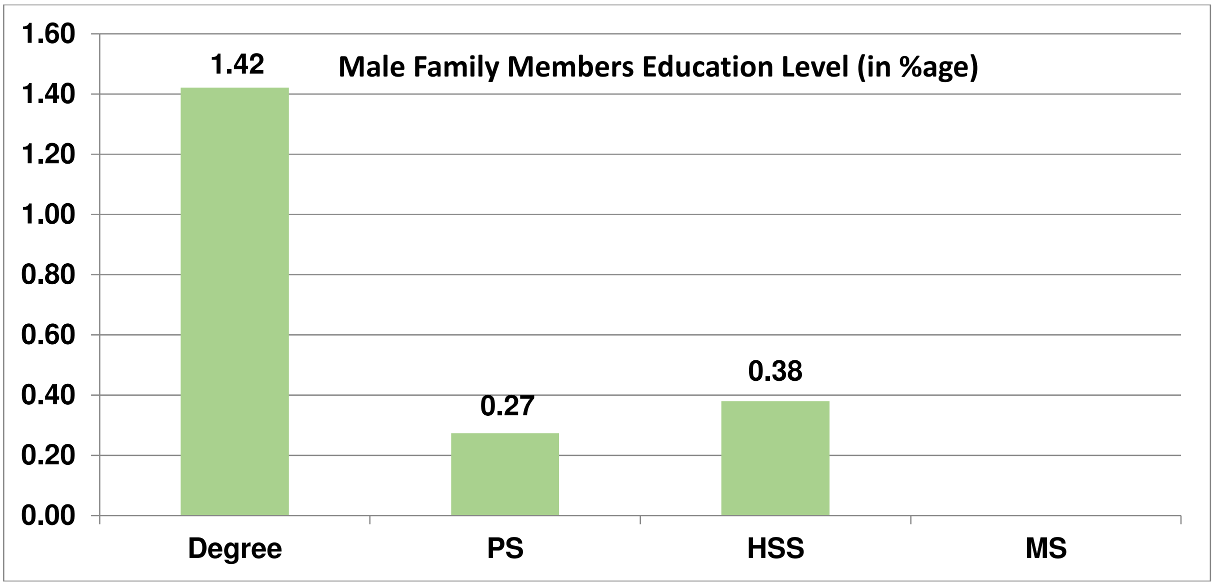
8.6.3 Potential Income Diversification Options

259. The survey data reveals that the potential income diversion options identified are as follows;

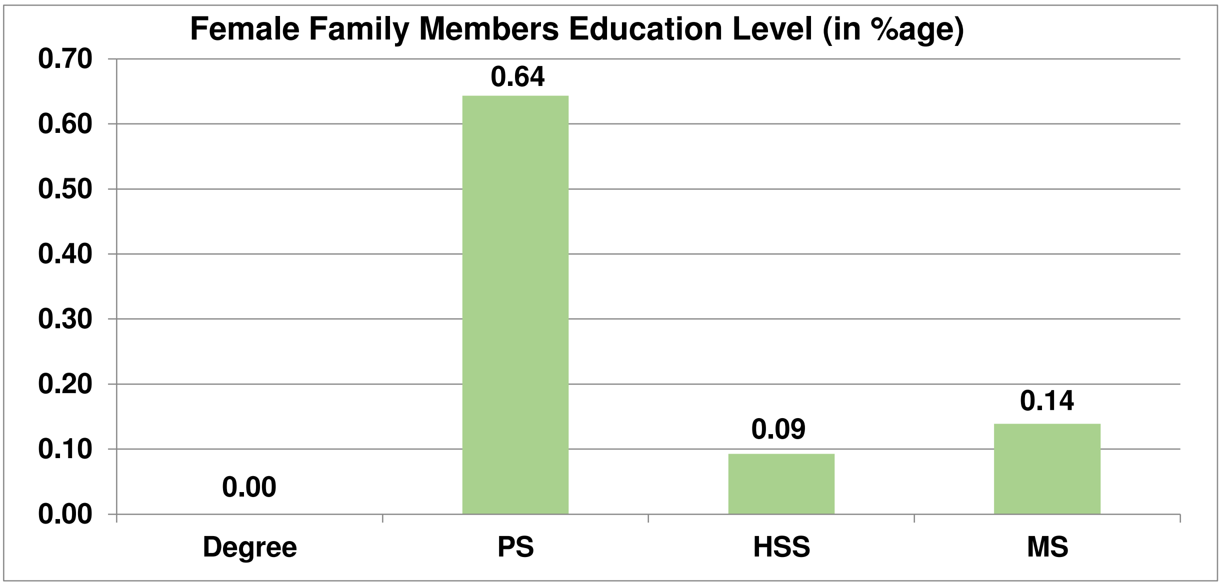
- Command area development works under the project;
- Development of Khushkaba land; and;
- Concentration to the livestock rearing.

8.6.4 Education

260. The education level is very low as indicated in the following graph, there are no students of the professional studies (engineering & medical), the sixteen year education is only 1.42%, matric level education is 0.38% and primary level education is 0.27% among the male family members.



261. Similarly, the education level in the female family members is also very low as indicated in the following graph, there are no students of the professional studies (engineering & medical) and the sixteen years education level is only 0.14%. The matric level education is 0.09% and primary level education is 0.64%.



8.7 Archaeological and Historical Sites

262. There is no sites of archaeological and historical importance in the sub-project corridor

8.8 Land Use and Availability

263. The revenue record is registered in the name of Mouza Ahmad Khel and Thappa Gastoi with Revenue Department Zhob. The revenue record established on 19th November, 1969, reveals that the total registered land is 3,981 acres and 34 poles. The irrigated land is 91 acres and 38 poles while un-irrigated land is 3878 acres, 3 rods and 38 poles. The record indicates that most of the land under Mouza Ahmadkhel is distributed among the landholders.

264. Nearly all landholders reported in the above Table have pieces of lands as the land in the sub-project area is distributed by Karezai and Irabzai lineage of Clan Ahmadkhel tribe Mandokhel. Almost all the land is distributed among on Sectoral Lineage level and for further distribution on the level of unit household, during consultation, the community committed to among the legal shareholders before commencement of the physical works on the Core-Sub-Project. A committee has been formed by the shareholders to look into the matter and distribute the land among the shareholders according to their tribal traditions. About 4027 ha is the expandable land which could be commanded from the same source. While currently the left bank land cannot be commanded from the same source, therefore the farmers have developed tube wells in the left bank command area. However, if the sub-project is developed these lands could also come under command. In the watershed of the sub-project no villages were reported by the community and there was nearly no access in the watershed through vehicle. The land in the watershed/catchment beyond the proposed reservoir poundage is reportedly belongs to the Arabzai clan.

8.9 Water Rights

265. Currently there is no irrigation over the Siri Toi River, in rare cases tube well irrigation was observed.

8.10 Irrigation Sources and distribution

266. As currently there is no irrigation over the Siri Toi River. However, it is clear that the water rights will goes to the people who had land rights in the command area of the proposed dam. There are 864 land holding resident families in Tangi War/ Siri Toi dam area. They water rights will be established with the cooperation of EA/ID and ACD OFWM and it is expected to be time bound division and based on land size of individual landowner.

8.11 Issues and Options on Water & LAND Rights

267. Three of the complaint registered by (i) Muhammad Karim, (ii) Haji Muhammad Khan and (iii) Haji Shah Baz Khan through email address karimirrebzai@gmail.com. Before this email, these complaints raised their concern/issue during the ADB workshop in Serena Hotel Quetta on 8th and 10th April, 2017 while the field survey was completed and accordingly it was made part of the pre-feasibility report and immediately the community/beneficiaries of Siri Toi/Tangi War Dam was sensitized to resolve the matter amicably. In response to the complainant's email, the PPTA visited the site in consultation with the Deputy Commissioner Zhob and along with the Patwaris/Qanoongo of Revenue Department Zhob office and the detailed report highlighting their concerns and suggested corrective measures was submitted to ADB and EA. (See Annex-I-).

8.12 Tenancy Arrangements

268. Tenancy is not very common; however, it is practiced. The land is cultivated beyond the command of the proposed Siri Toi Dam where water is permanently available.

8.13 Gender Issues

269. Primary and Secondary information was also reviewed to assess gender situation at the district level. Consultations were made with female members of the surveyed households to assess the socio-economic status of women and document gender differences and discussed. It was observed that a nominal number of women involved in agriculture/ farming activities in the field.

270. Tribal norms and traditions are deep rooted in the area with little involvement of women in decision making. The male child is preferred over the girl child in education, health etc. The females play a limited role in income generating activities and their work is undervalued. Though a wide gender gap, still they are contributing to household economy. As reported in PSLM, in 46% of cases in urban areas and 28% cases in rural areas, parents did not allow the girls to attend School. In 23% cases, the girl child did not attend school because she had to help at home against only 5 percent boys.

Table 30 - Reasons for Never Attending School (10-18 Years), in 2005-06 - %

Reason	Urban		Rural	
	Boys	Girls	Boys	Girls
Parents didn't allow	1	46	1	28
Too expensive	27	9	15	5
Too far	0	1	12	11
Education not useful	0	0	1	0
Had to help at work	9	5	20	4
Had to help at home	1	10	5	23
Child not willing	44	18	21	14
Other	18	12	25	14

Source: PSLM, Statistics Division, GoP, Table 2.24

271. The entire society of Zhob district is male and tribally dominated. Men decide on politics and the fate of the family and tribe. Therefore, they assume a predominant role in both the community and family decision making. The rate of literacy amongst women is very low. Female participation in elections has increased since 1985. Previously, women were discouraged to vote. Women play a minor role in decision-making, but they play an important role in the household and agricultural affairs of the district. According to MICS Balochistan 2010, female literacy rate 1 (15 years and above) is 9.3%

8.13.1 Project Impacts on Women's Mobility and Access

272. The women occasionally travel outside their villages, mostly for visiting doctors, shopping and social events. Very few girls travel for education or to access vocational facilities located in the urban centers of Zhob. Women concerned that, during the project execution, their travel time and privacy as well as their social networking may be affected, although there is nominal number of women involved in agriculture/farming activities in the field as well as outside their houses/ villages.

273. In this context, a proper mitigation measures need to adopted to avoid/ or minimize such disturbances, although these will be temporary. There would not be a significant mobility issues for women during this irrigation project execution as no or a minimal number of women are working in farm fields and out of their houses/ villages.

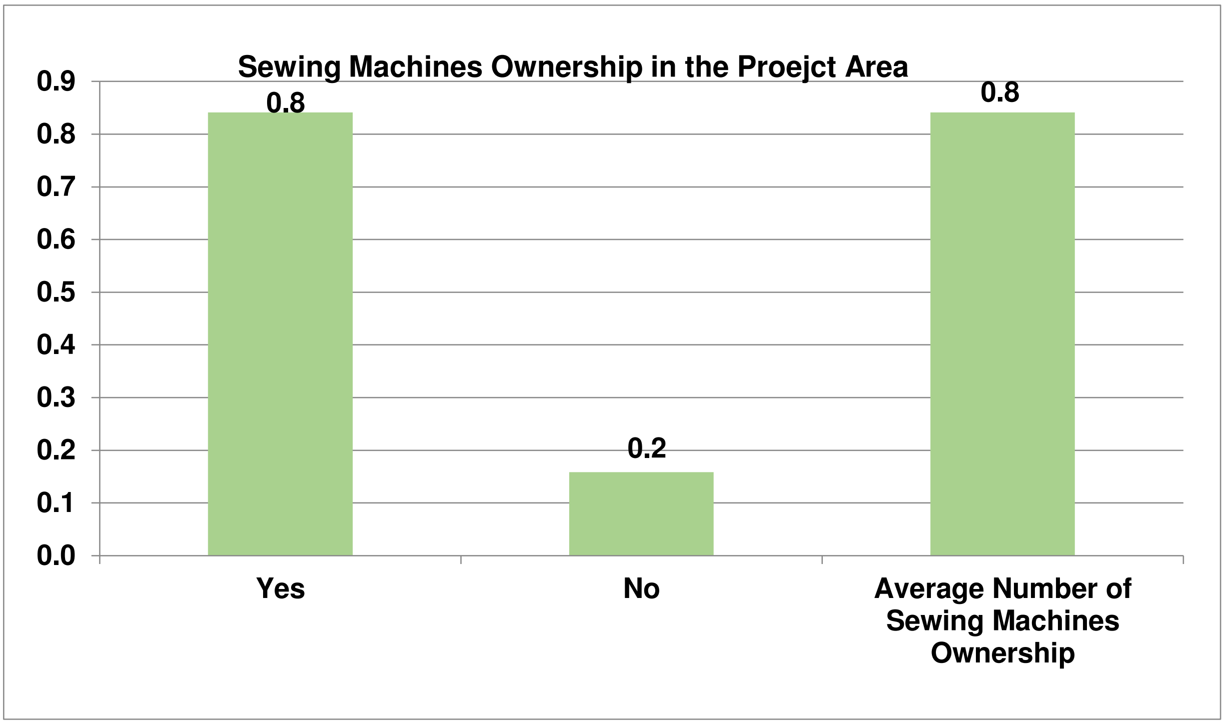
8.13.2 Women's Participation in the Decision making at the Household

274. During consultations, it was found that the majority of decisions are taken by both men and women at the household level. However, the decision for women to work outside home is 100% taken by men. This also indicates restricted mobility of women outside the village. Women shared that women's participation in decision making is more encouraged and

common in educated families and younger generation. Educated couples believe in sharing and taking joint decisions.

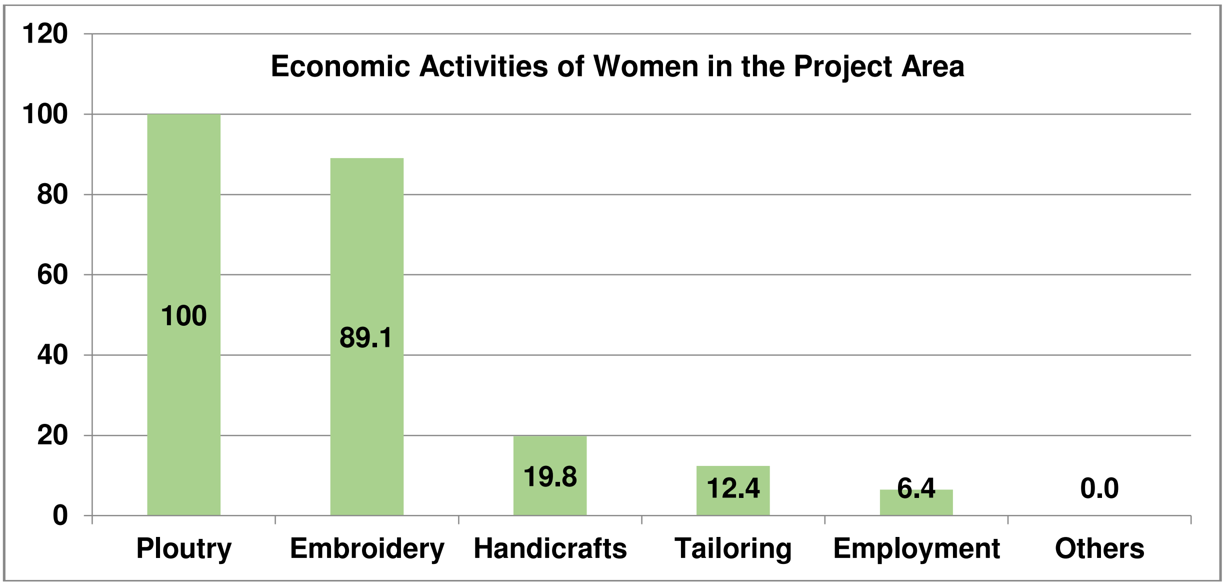
8.13.3 Livelihood Source & Economic Activities of Women

275. The ownership of sewing machine is a source of income for the women in the project area. 100% of the households have the ownership of sewing machines in the project area.



276. Chicken rearing is another economic for women in the project area. The survey data reveals that 97% of the women in the project area have ownership of poultry. The women do not sell out chicken in the market but it is only used for domestic consumption. The major economic activities of women in the project area illustrated in the following graph which reveals that;

- Poultry rearing is common in the project area;
- Embroidery as source of income for 89.1% of women in the project area;
- Handicraft as a source of income for 19.8 of women in the project area;
- Tailoring is as a source of income for women of 12.4%;
- Government employment is as a source of income for 6.4% of women.



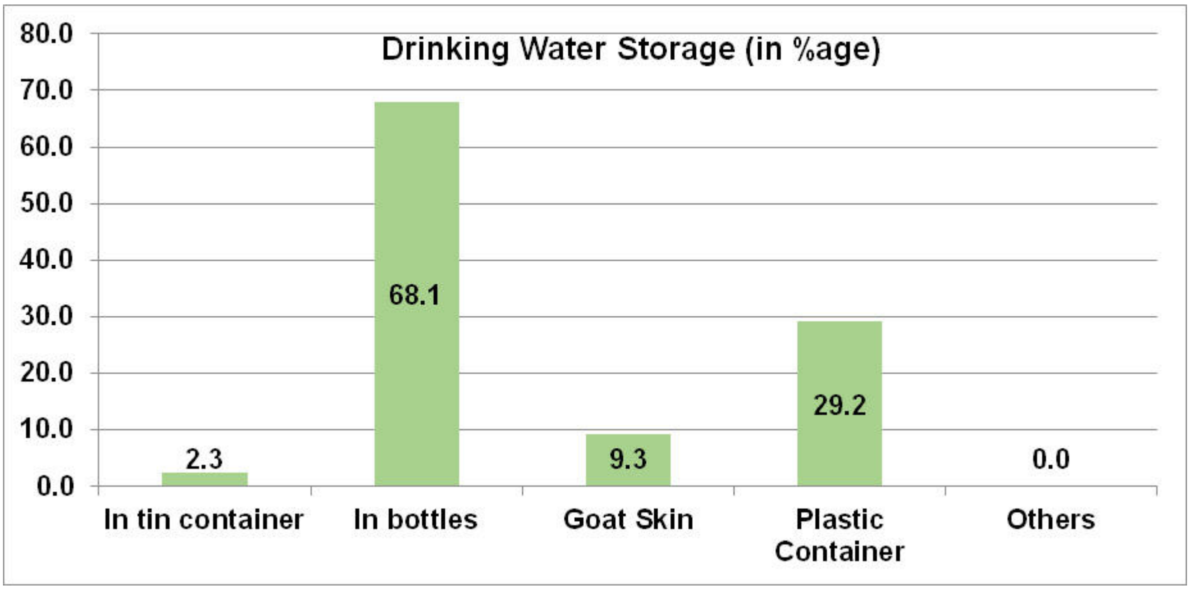
277. The women of the project area do not play role in the agriculture and watershed management activities.

8.13.4 Women Role in Livestock Rearing

278. Both men and women are engaged in livestock activities; men are responsible for the animal's health as this entail outside activity; and' women are involved in activities such as watering, feeding and milking. Most women are also engaged in processing dairy products including whey, butter for home consumption. None of the women interviewed own neither livestock nor they authorized to sell animals. Women have no rights in land ownership and there is no female headed household in the project area. As per Islamic law, the women are not given their due share in from the paternal side and share in case the husband is deceased.

8.13.5 Potable Water

279. As per field findings of the integrated survey, 100% of the women fetch water from hand pumps located inside their compound. Water from these sources is also used for washing dishes and clothes. Women and girls are responsible for fetching water for domestic purposes. The average time spent in a day for fetching water 3.88. All women stated they make four or five more trips a day to collect water. Respondents considered fetching water to be their most physically difficult or time consuming activity. Most of women have some notion of the need for clean drinking water but drinking water is neither filtered nor boiled in any of the respondent's household. As portrayed in the following graph, 68.1% of the women store water in bottles, 29.2% of the women store water in plastic containers, 9.3% of the women store water in goat skins and 2.3% for the women store water in iron containers.



8.13.6 Health & Hygiene

280. No modern health facilities are available in the project area. There is a lady health assistant, who is attending delivery cases of the women. Knowledge of the nutritional value of food and the importance of balanced diet is very limited. Respondent women reported a prevalence of various health problems including diarrhea, abdominal pain, malaria and skin diseases; most children are said to suffer from skin disease.

281. 100% of the women reported in the project area that they do not boil water before drinking. It was reported that water storage container were kept covered. There are no standard toilets and common pits are used. There is no sewerage system in the project area. 97% of the women were observed washing their hands before eating and after using common pit toilets, kneading floors and cooking while remaining did not permitted the team for survey.

8.13.7 Women Role in Agriculture

282. Two third of the women interviewed were not involved in agriculture activities in the fields of their husbands or relatives. Women do not grow vegetables for home consumption inside their compound.

8.13.8 Women Priority Needs

283. During survey, Sub-Consultant women team assessed following needs of women in the project areas;

- Training in health and hygiene;
- Provision of female education facilities;
- Employment;
- Kitchen gardening; and;
- Development of water collection and Washing Ghats under the project.

8.14 Community Priority Needs

284. During public consultation and baseline survey in the project area, the needs of the communities were assessed. The baseline reveals the following demands priority wise the following demands;

- Construction of dam and command area development works'
- Provision of water supply to the communities falling in the immediate vicinity of the dam.

8.15 Public Consultation

285. Total 3 [4]consultative (54 participants) discussions with local community were made along the project route alignment. The information disclosure to the people kept limited as this is ` tentative alignment at this stage. However, detailed disclosure of information will be made after the detailed design of the project alignment. As no agriculture is practiced in the sub-project therefore most of the beneficiaries are dependent on livestock, labor, business and employment with government/private agencies for their livelihood. While in each household some family members are non-residents due to their jobs and other source of income. No dispute was reported on land and water rights during the survey of 17 villages and the farmers were agreed to participate in the sub-project development.

286. However, during the workshop of ADB on 8th February at Quetta Serena, one beneficiary of the sub-project and Officer at Agriculture Department Karim Mandokhel came and objected that the land of the dam site and rangelands at the side of the watershed belong to him and he also have land in the proposed command area. Therefore he would not allow the sub-project until the whole land of Arbzai Tribe which would come under command is distributed among all the shareholders. He was told that the matter of distribution of land is fully the matter of their tribe and they should resolve this issue themselves, however for the compensation of land at the dam site it would be surveyed that how much of the land would be damaged.

287. Later on, the complainant sent an email to ADB and EA/ID to express his grievances. IN response, the Chief Engineer EA/ID wrote a letter to the concerned Commissioner and Deputy Commissioner to intervene and resolve the matter amicably. The PPTA team also paid visit to investigate the matter. Accordingly a report is prepared and is given as Annexure.

288. During the survey people were asked about their views regarding the proposed project. In general, people have positive thinking and good hopes about the project as according to them it will be beneficial for their agricultural land and eventually this canal will raise the productivity of their land. Some general concerns of the people are as follows in Table 28, 29 and 30:

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[4] *The inhabitants of all villages were gathered on these three locations keeping in view their close proximity to the consultation venue.*

Table 31 - Summary of Public/ Stakeholder Consultations-Hazrat Sahib Village

Meeting date & time	Location	Stakeholders participating		Key Issues/Topics Discussed
		Names of Project Proponent & PPTA Consultants	Names & Type of Participant	
NAME OF VILLAGE: Sri Toi Storage Dam(Hazrat Sahib Village)				
31-01-2017 Tuesday 11:00 Am	Hazrat Sahib Village	Naimat Ullah (Team Leader)	Land Owners from Hazrat Sahib, Doshana, Sun Kasai, Zawi	1. The stakeholders were completely willing for the development of their scheme and were ready to cooperate with the project team during scheme development. 2. The community was also willing for the cash and labor contribution at their end. 3. The stakeholders also agreed for the gender activities during the scheme development. 4. The stakeholders told that their land is communal and distribution of land is under process

PHOTOGALLERY

Venue of Meeting: Public Consultation in Village Hazrat Sahib
Date: 31st January 2017

Figure 31 - Public consultation meeting in village Killi Hazrat Sahib

Figure 32 - Public consultation meeting in village Killi Hazrat Sahib

Figure 33 - Public consultation meeting in village Killi Hazrat Sahib

Figure 34 - Discussion with the participants

Phase-IIa: Attendance of the Participants for Public Consultation

Village Name: Hazrat Shahib Killi Sub-Project: Sari Toi Dam

S#	Name of the Participant	Father's/Husband Name	Contact No	Signature/Thumb Impression
1	Qari Sanauhaq	Hazrat Shahib		قاری ثناء الحق
2	Shibzadh Noorulhaq	"		صاحبزادہ
3	Habibu Haq	"		[illegible]
4	Shafiq u Haq	"		شفیع الحق
5	Amin u Haq	"		[illegible]
6	Zahoor u Haq	Aminuhaq		Zahoor
7	Baseer u Haq	Qari Sanau Haq	03443666630	[illegible]
8	M. Rafiq	H. Abdul Razaq		Rafi
9	Abdul Salam	Abdul Sattar	03138294443	A. Sallam
10	M. Sadeeq	Abdul Razzaq	03138364039	Sadiq
11	Abdul Ghafar	Abdul Sattar		عبد الغفار
12	Hafiz Shamsudin	Abdul wahab	03138656058	Shamsudin
13	Abidullah	Hameedullah	03053908069	[illegible]
14	H. Fazal Din	M. Nizamudin	03003480392	[illegible]
15	Mohd Hasham	Ghulam Qadir	03009043774	[illegible]
16	M. Haneef	M. Qasim	"	
17	Haji Amin. M	Hazrat Shahib	03002729201	امیر الحق
18	Sami u Haq	Haji Amir. M	"	[illegible]
19	Imdad. ullah	Hameedullah	03133994765	امداد اللہ

Table 32 - Summary of Public/ Stakeholder Consultations-Sur Ghund Village

Meeting date & time	Location	Stakeholders participating		Key Issues/Topics Discussed
		Names of Project Proponent & PPTA Consultants	Names & Type of Participant	
NAME OF VILLAGE: Siritoi Storage Dam(Surghundi Village)				
28-01-2017 Saturday 11:00 Am	Surghundi Village	Naimat Ullah (Team Leader)	Land Owners	1. The stakeholders were completely willing for the development of their scheme and were ready to cooperate with the project team during scheme development. 2. The community was also willing for the cash and labor contribution at their end. 3. The stakeholders also agreed for the gender activities during the scheme development. 4. The stakeholders told that their land is communal and distribution of land is under process

PHOTOGALLERY

Venue of Meeting: Public Consultation in Village Surghundi Date: 27th January 2017

Figure 35 - Public consultation meeting in village Surghundi

Figure 36 - Public consultation meeting in village Surghundi

Phase-IIa: Attendance of the Participants for Public Consultation

Village Name: Sur Ghundi / Sobi Arizgai Sub-Project: Sari Tai DAM

S#	Name of the Participant	Father's/Husband Name	Contact No	Signature/Thumb Impression
1-	Malak Baz M	Malak Doulat Khan		ملک باز
2-	Haji Noor Khan	Mohd Daraz Khan	0313-8752783	نور خان
3-	H. Mohd Shafiq	Haji Jami	03063943743	[illegible]
4-	Malik M. Zaman	Malak Sultan M	03023837888	[illegible]
5-	M. Daoud Khan	M. Ali	03487795800	[illegible]
6-	Mohd Zahid	M. Rafiq	0313-8297583	Zahid
7-	Wakeel Khan	M. Shafiq	03493719478	[illegible]
8-	Sami ullah	Azizullah Jan		Sami ullah
9-	Dilawar Khan	M. Rafiq		[illegible]
10-	AmanaTullah	"	0347-239209	[illegible]
11-	Abdul Hadi	"		Abdul Hadi
12-	Mohd Hanaf	M. Sadiq		Hanif
13-	Hayat Khan	Hassan Khan	0344-8877152	[illegible]
14-	Ilyas Khan	M. Zahid	03481216128	[illegible]
15	Muhammad Afzal	A. M. Rafiq	03412221021	[illegible]
16	Yar-Mohd	H-Gul-M		[illegible]
17	Ghulam-Mohd	Faizullah		[illegible]
18	Abdul wahid	H.A. Haleem		Abdul [illegible]

عنبر گہ گدائی

Table 33 - Summary of Public/ Stakeholder Consultations-Thora Daraga Village

Meeting date & time	Location	Stakeholders participating: Names of Project Proponent & PPTA Consultants	Stakeholders participating: Names & Type of Participant	Key Issues/Topics Discussed
NAME OF VILLAGE: Siritoi Storage Dam(Tor Darga Village)				
30-01-2017 Tuesday 03:00 Pm	Tor Darga Village	1. Naimat Ullah (Team Leader)	Land Owners from Tor Darga, Killi Lorhak	1. The stakeholders were completely willing for the development of their scheme and were ready to cooperate with the project team during scheme development. 2. The community was also willing for the cash and labor contribution at their end. 3. The stakeholders also agreed for the gender activities during the scheme development. 4. The stakeholders told that their land is communal and distribution of land is under process

PHOTOGALLERY

Venue of Meeting: Public Consultation in Village Tor Darga - Date: 30th January 2017

Figure 37 - Consultation in Tor Darga

Figure 38 - Consultation in Tor Darga

	
Figure 39 - Consultation Meeting at Command Area	**Figure 40 - Consultation Meeting at Command Area**

30/1/2017

Phase-IIa: Attendance of the Participants for Public Consultation

Village Name: Tora Dargai Sub-Project: Sari Toi Dam

S#	Name of the Participant	Father's/Husband Name	Contact No	Signature/Thumb Impression
1	Malak Baz Mohd	Malik Daulat Khan		[signature]
2	Teemoor Shah	Mala Dad Mohd	03386708?2	[signature]
3	Mohd Ismail	Baz Mohd	03368020629	[signature]
4	Naseeb Gul	Khan Mear		[signature]
5	Abdul Wahid	M. Hassan	0344 8289272	[signature]
6	Zahir Khan	Abdul Qadar		[thumb impression]
7	Dadak	Haji Moras		[thumb impression]
8	Mohd Qasim	Baz Mohd		[signature]
9	Naseebullah	muhammad Rafiq	03440394784	[signature]
10	Habib Khan	Ahmad Khan	03138872344	[signature]
(11)	Azmeer Khan	Hakim Khan	03334966068	ازمیر خان
12	A. Aziz	Tawez	—	
13	A. Rahman	Alizullah	—	[signature]
14	Khan Mir	H. A. Razaq	—	
15	Habibullah	M. Ayoub	—	[signature]
16	Bajarh	H. Sahibjan	—	[signature]
17	Abdul Ghani	Bajar		

Orakh Haq Killi (rows 12–17)

8.16 IR and IP Screening

289. Involuntary resettlement (IR) and issues related to indigenous people (IP) were assessed for the sub-project in line with the ADB SPS and standard checklists.

8.16.1 Involuntary Resettlement

290. During field visits, it was confirmed that the main dam axis, its reservoir, dykes, spillway, left and right bank irrigation canals are siting on private land. Therefore; acquisition of land for the construction of the above mentioned structures is required. Thus the subprojects is classified as Category "B”·for IR and Accordingly, in line with the ADB SPS and LARF prepared for the project, a sub-project specific Land Acquisition and Resettlement Plan (LARP) will be prepared. Table 31 describes the detail of the impacts.

Table 34 - Involuntary Resettlement Impact Categorization Checklist

Probable Involuntary Resettlement Effects	Yes	No	Not Known	Remarks
Involuntary Acquisition of Land				
1. Will there be land acquisition?	X			Private land in the dam reservoir will be submerged/ inundated , proposed dam axis, dyke, spillway, access road, left and right bank irrigation canals will require permanent land acquisition. Some temporary land will be required for the construction period like contractor main and site camps.
2. Is the site for land acquisition known?	X			
3. Is the ownership status and current usage of land to be acquired known?	X			
4. Will easement be utilized within an existing Right of Way (ROW)?	X			
5. Will there be loss of shelter and residential land due to land acquisition?		X		There are no structures within the RoW of the proposed infrastructure in particular where acquiring of land is required.
6. Will there be loss of agricultural and other productive assets due to land acquisition?		X		There is no agriculture in the RoW of the proposed infrastructure in particular where acquiring of land is required.
7. Will there be losses of crops, trees, and fixed assets due to land acquisition?		X		There is no standing crops, trees and productive assets while acquiring the land for the proposed project.
8. Will there be loss of businesses or enterprises due to land acquisition?		X		

9. Will there be loss of income sources and means of livelihoods due to land acquisition?		X		Small piece of cultivable land is falling in the reservoir of the proposed dam. Reportedly, this piece of land was cultivated in the past and currently for the last 5-8 years; this piece of land is not cultivated. The owner of the land committed with the team to dedicate this piece of land for the proposed dam to get benefits of the project in future.
Involuntary restrictions on land use or on access to legally designated parks and protected areas				
10. Will people lose access to natural resources, communal facilities and services?		X		
11. If land use is changed, will it have an adverse impact on social and economic activities?		X		
12. Will access to land and resources owned communally or by the state be restricted?		X		
Information on Displaced Persons:				
Any estimate of the likely number of persons that will be displaced by the Project? [ ] No [ ] Yes If yes, approximately how many? _______ _______________				
Are any of them poor, female-heads of households, or vulnerable to poverty risks? [ ] No [ ] Yes				
Are any displaced persons from indigenous or ethnic minority groups? [ ] No [ ] Yes				

Note: The project team may attach additional information on the project, as necessary.

8.16.2 Indigenous People

291. The subproject is located in District Zhob of Balochistan Province where no indigenous or ethnic minorities (EM), as ADB SPS describes them to be, have been found living in or around the selected subproject areas. All persons are Muslim and they do not recognize themselves as IPs. The ADB's policy on IPs is therefore not triggered. Therefore these subprojects have been categorized as "C" for IPs and no Indigenous peoples plan will be needed. Table 32 describes the detail of the impacts.

Table 35 - Indigenous Peoples Impact Categorization Form

A. Project Data

Country/ Project Title: ADB TA:8800:PAK: Balochistan Water Resources Development Project

Department/ Division: CWER **Processing Stage:**

Retroactive Financing: [ ] **New Project:** [X]

Lending Modality:

[ ]	Project Loan	[ ]	Financial Intermediation Loan or Equity Investment
[ ]	Program Loan[5]	[ ]	Emergency Loan
[X]	Sector Loan	[ ]	SDP Loan

Categorization Status: New [X] Re-classification [ ] Previous Category [ ]

Identification of indigenous peoples in project area

Impact on indigenous peoples (IPs)/ ethnic minority(EM)	Not known	Yes	No	Remarks or identified problems, if any
Are there IPs or EM groups present in project locations?			X	
Do they maintain distinctive customs or economic activities that may make them vulnerable to hardship?			X	
Will the project restrict their economic and social activity and make them particularly vulnerable in the context of project?			X	
Will the project change their socioeconomic and cultural integrity?			X	
Will the project disrupt their community life?			X	
Will the project positively affect their health, education, livelihood or social security status?			X	
Will the project negatively affect their health, education, livelihood or social security status?			X	
Will the project alter or undermine the recognition of their knowledge, preclude customary behaviors or undermine customary institutions?			X	
In case no disruption of indigenous community life as a whole, will there be loss of housing, strip of land, crops, trees and other fixed assets owned or controlled by individual indigenous households?			X	

C. Anticipated project impacts on indigenous peoples

Project activity and output	Anticipated positive effect	Anticipated negative effect
Does Not Apply As There are no Indigenous People in Sub-Project Area.		

D. Decision on Categorization

After reviewing the answer above, the head Environment and Social Unit (ESU) agree that the project:

[ ]

[5] *Applies to program loans with investment components.*

Should be categorized as an A project, an Indigenous Peoples Development Plan (IPDP) is required or, for sector/FI projects, an Indigenous Peoples Development Framework (IPDF) is required

☐ Should be categorized as a B project, a specific action favorable to indigenous peoples/ethnic minority is required and addressed through a specific provision in RRP and in related plans such as a Resettlement Action Plan, a Gender Action Plan or a general Community Participatory Plan

☒ Should be categorized as a C project, no IPDP/IPDF or specific action required

Project Team Comments: The project area is falling in District Zhob of Balochistan Province and there is no Indigenous People in the project area.

8.16.3 Mitigation Measures

292. The anticipated impacts of acquiring land is unavoidable; therefore; in line with the Land Acquisition and Resettlement Framework (LARF), sub-project specific LARP has been prepared.

9 ENVIRONMENTAL IMPACTS & MITIGATIONS STUDIES

293. This chapter identifies the significant potential environmental and socio-economic impacts which may occur during the project life. A brief qualitative description of the each aspect, the affected environment in the Project Area and the appropriate mitigation measures are discussed and the details are presented in the TA-8800-EIA Report of Siri Toi Dam.

9.1 Scoping of Impacts

294. Potential environmental impacts of the Project on various environmental features in the Project Area are identified through the following studies:

- Environmental quality baseline monitoring of air, noise and water;
- Detailed review and analysis of primary and secondary data available for all environmental parameters in Project Area such as physical, ecological and social resources;
- Desktop study of engineering investigations, studies and designs;
- Consultations with implementing agencies, local government, affected community, traditional and religious leaders of community;
- Stakeholder consultations with relevant government agencies and national NGOs;
- Knowledge assimilation of international best practices on environmental assessment of irrigation projects.

9.2 Notion of Significance

295. The term "*Environmental Impact*" or simply "Impact" covers the negative, adverse or harmful as well as positive, desirable or beneficial impacts of the project on environmental settings. Prediction of impacts of the proposed activity is based on factual data; however, the significance of these impacts involves subjective judgment. The nature of the impacts may be categorized in terms of:

- Direction - Positive or Negative
- Duration - Long or Short Term
- Effect - Direct or Indirect
- Extent - Wide or Local

296. Impact significance depends on both the nature of the impact and on the sensitivity of the receptor. The more sensitive the receptor the greater will be the significance of impact of that change. For this EIA Report, nature of change is combined with the sensitivity of the receptor to evaluate the significance of the impact. The significance of impact is characterized as very low, low, moderate, high and very high. Environmental issues having "moderate", "high" and "very high" significance would be provided with mitigation measures.

9.3 Positive Impacts Due To Siri Toi Water Storage Dam and Irrigation System

297. Positive impacts due to proposed interventions are presented in Table 33 with their enhancement measures:

Table 36 - Positive Impacts of proposed interventions

Positive Impacts	Enhancement Measures
Employment opportunities to some local folks for design phase surveys.	Detailed design consultants should employee local people as much as possible.
An anticipated positive impact on socio-economic conditions during construction phase is the creation of limited-time employment opportunity for the local population. Since the project interventions will require substantial input from manual labor, even people with relatively lower levels of education or skills could get short term employment.	The contractor will be liable to engage at least 50% of its required (unskilled) labor force from within or around the Project Area.
A substantial land will be irrigated under the proposed scheme.	-
Household income will increase substantially with irrigation improvement measures owing to availability of water for irrigation, crop yields, increase in the number of animals, and availability of other occupational opportunities.	-

9.4 Environmental Screening

298. Table 34 below presents the screening of activities for proposed Siri Toi water storage dam and irrigation system during design, construction and O&M phases:

Table 37 - Screening of Activities

Proposed Sub-activities	Screening Results			Potential Impacts
	Very Low Risk	Moderate Risk	High Risk	
Construction of Dam, Canal, Distributaries & Minor and Irrigation Structures				
A. Design & Planning Phase				
Topographical survey and Geotechnical investigation of the area	✓			No potential Impact
Assessment of water availability		✓		Failure of design
Water rights issues in the area		✓		Social issues
Public disclosure of final design	✓			No potential Impact
Coordination with all relevant departments for NOCs		✓		Delay in project implementation & cost overruns
Permanent land acquisition	✓			No potential Impact as land distribution activity from tribal level to individual level has done through DC Zhob.
Loss of crops	✓			No potential Impact
Disruption to public life	✓			No potential Impact
Disruption to wildlife	✓			No potential Impact
B. Implementation & Construction Phase				
Construction contractor mobilization and establishment of campsite and machinery/ equipment Yard		✓		Changes in land use pattern Influx of external work force Social conflicts Workshop facilities may spread oils & chemicals Deterioration of air quality due to machinery & equipment Noise Land degradation due to solid waste disposal of camp site Health and Safety issues
Transportation of construction material		✓		Air pollution
Excavation, backfilling and compaction works		✓		Site overburden Borrow pit Sites of Historical, Cultural, Archeological or Religious Significance Noise pollution Air pollution Health and safety issues

C. Operation & Maintenance Phase				
Construction of structures		✓		Noise pollution Air pollution Health and safety issues
Breaching of dam, canal, distributaries and structures		✓		System sustainability
Use of irrigation water for drinking purposes	✓			Health issues Social issues
Use of fertilizers & pesticides			✓	Banned fertilizer & pesticides will cause health issues Contamination of fresh water through surface runoff
Increase of agricultural and pastoral lands	✓			No potential Impact
Periodic cleaning and maintenance of the system		✓		Solid waste generation
Community Participation for management and operation of the irrigation system	✓			No potential Impact

9.5 Anticipated Environmental Impact due to project

299. The project and its activities may have a potential to impact the environment and this section intends to evaluate the significant impacts. It is imperative that the project is considered into its different aspects. The following environmental impact aspects have been evaluated:

- Impacts owing to Design Phase
- Impacts owing to Construction Phase
- Impacts owing to Operations Phase

300. Understandably, the potential environmental impacts, in a physical sense, of the design stage are quite low. Since the design stage involves only limited physical activity, its direct impact on environment is also low. The various surveys carried out at the planning level may result in short term impacts on air and soil quality. If the design is carried out without regard to the environmental considerations, it will lead to long term negative implications for local flora, fauna, water quality, water resources, land acquisition etc.

301. The following sections dilate upon the environmental issues and the assessment of their impacts. It is to be noted that since most impacts will be similar irrespective of the project component, the description follows a phase wise approach. However, whenever any particular impact is envisaged to be linked to a specific component, the description has been adjusted accordingly.

Table 38 - Environmental impacts during design, construction and Implementation Phases of Siri Toi Dam.

Issue	Potential Impact	Mitigation Measures
Impacts during Planning and Design Phase		
Assessment of Water Availability	Improper assessment of water availability and failure of design. This impact would be of high significance.	Design works will ensure the proper assessment of water availability.
Water Rights Issues in the Area	The EIA team found that generally people in the area are living in harmony without any major social fault lines based on ethnicity, religion, caste or creed. Water being the most precious commodity in the area, its usage rights has been established traditionally. Any perceived or real disturbance to these water rights will almost certainly lead to social disturbance in the area. This impact would be of high significance	Proper water distribution through “Warabandi System” engaging Water user Associations and traditional jirgas. Traditional jirgas will prove to be an important guide at the design phase for water rights. Their inputs will need to be minutely considered while carrying out the detail designs. Coupled with this, continual two-way communication with the local population will be necessary, to ensure that their perceptions about the project remain realistic, rational, and positive. Conduct social surveys to involve local public at the maximum in design phase, and probe ways and means to tackle these issues so as to maximally benefit them from the proposed project. By adopting the measures, the impact would be of low significance
Coordination with all Relevant Departments for NOCs	Under the current mandates of various departments, the proposed project will need approvals and NOCs from various government departments e.g. BEPA etc. These approvals take substantial time and cause delays in project implementation and undue cost overruns. This impact would be of moderate significance	The most important mitigation measure, however, remains satisfactory level of inter-departmental coordination. Once the draft feasibility is ready, the proponent i.e. Balochistan Irrigation and Power Department, should call a meeting of all stakeholder departments and present the project. The meeting should discuss and finalize the role and contribution of various departments in the project. This will be in line with the advice given by various stakeholders during consultations. By adopting the above measure, the impact would be of low significance

Impacts during Implementation and Construction Phase		
General Impacts	The construction phase of the project might result in a number of environmental aspects that are identified in this section. Activities that have been perceived as potential sources of these environmental concerns are also discussed. These environmental aspects may create temporary hazards of moderate significance to the environmental resources of the Project Area during the project construction phase. However, if managed properly these activities will not pose any serious threat to the environment. The main responsibilities for mitigation during the construction phase of the project rest with contractors appointed to construct the various interventions. BIPD's Chief Engineer will have the responsibility to manage the monitoring of implementation of mitigation measures by the contractors and implement his own system of internal checks. In order to avoid creation of misunderstandings regarding who is responsible for particular activities recommended for the construction phase, the proposed mitigation measures (in the form of a plan) should be appended to tender documents. This will ensure that contractors include the cost of mitigation actions into their bids and will provide a reliable mechanism for enforcement. In fact, most of the recommended actions involve no or very little capital investment, but it depends on the contractor's management to adopt a responsible attitude to environmental protection; ensuring construction activity is being properly planned and mitigation actions are correctly implemented. This EIA document attempts to enlist all major potential impacts of the project, and their likely mitigations. These impacts and mitigations will be presented in the form of an EMP in the next chapter of this document. During the stakeholder consultation meetings, they strongly mentioned the need to establish a formal mechanism to monitor project progress in terms of environmental compliance. Once the project construction starts, and through its operations phase, the most likely source of environmental or social impact could be non-compliance of EMP by the concerned entities; whether willingly or otherwise	The project proponent will hire an independent monitoring consultant firm, for regular monitoring of the Project. The firm will submit progress and monitoring report, as per BEPA and EMP requirements, on six monthly basis during construction phase. The frequency of monitoring will become annual during operations phase. The Proponent will also formulate an Environmental & Social Management and Monitoring Cell (ESMMC) which will review the project progress on periodic basis. This cell will comprise of senior professionals, and should preferably have representation from the various line departments e.g. Forest, local administration etc. The cell should also include at least one technical expert from R&D institutions (either from academia or international NGOs e.g. IUCN / WWF), and a representative from BRSP

Social and Culture Issues	There are chances of conflict due to cultural differences between mixing of Contractor’s workforce and the local inhabitants. In this situation, local residents may resist Contractor’s workforce attitudes, cultural clashes particularly when local/international contractors are engaged, social disturbance and dissatisfaction with employing outsiders, competition for natural resources may arise. This impact is temporary and minor negative in nature.	This impact can be mitigated by adopting the following mitigation measures: Timely and full public consultation and announcement of mobilizing equipment; Establishment of formal links with affected communities; Seek assistance from and cooperation with local NGOs; Familiarize outside laborers on local etiquettes; Local labor should be employed for construction works; and

All Construction Related Works		
Air Quality	During construction period, the impacts on air quality are mainly due to blasting material movement and the actual construction activities. Due to loading/unloading and stocking of construction material, the air quality over the immediate influence area will be affected and the PM levels in ambient air might increase, though not in significant levels. The emissions from diesel generator sets, construction equipment and vehicles may deteriorate the air quality in the area. Baseline results of ambient air quality as shown in Table 22 clearly shows that ambient air quality of the Project Area is currently clean as all the measured parameters are within the permissible limits of National Environmental Quality Standards (NEQS). Pollution causing activities during the construction phase are as follows: Transportation of construction and excavated material to and from the site in diesel fueled trucks would cause the production of combustion gases (CO, CO_2, NOx, SOx). Considering the scale of construction, the population size, and relatively clean environment, moderate impact is expected from this activity. However, the emissions would be of temporary nature. Considerable amount of dust would be generated from activity such as slope cutting, site clearance, excavation and transportation of excavated and construction material and concrete batching, but its effect would be of localized and temporary nature; and The concrete mixer used during concreting also causes above mentioned emissions. Based on the scale of construction and frequency of the operation, the impact of emissions is also assessed to be moderate but temporary.	In order to reduce the airborne dust emissions in the construction area due to material transport and construction activities, provisions will be made for sprinkling of water in the area where earth filling and excavation is being carried out. It will be ensured that the construction debris is removed daily. By adopting following measures, impact would be finally of low significance: During windy conditions stockpiles of fine material will be wetted or covered with plastic; PPEs such as dust masks will be made available to the construction workers at the site to avoid potential health hazards; Idling of delivery trucks or other equipment will not be permitted during periods of unloading or when they are not in active use; In no case, loose earth will be allowed to pile up along the approach roads; All vehicles and other equipment's used during construction will be properly and regularly tuned and maintained; All permanently deployed vehicles exhausts will be monitored against NEQS; and The possibility of excessive dust generation may be reduced by adopting the best construction practices, precautions such as periodic watering, covering of construction material and usage of low emission equipment's during construction. Although blasting is planned currently in any project activity, however at any latter stage during construction, blasting may be required for quarrying or any other activity. A blasting management plan has been attached in the EIA Report of Siri Toi Dam. Which need to be implemented.

Ambient Noise	During baseline survey, the recorded ambient noise level was found to vary between 48 to 65 dB (A). When the project activities would start, it is very likely that the existing noise level would be amplified. The major sources of noise pollution during construction activities would be during blasting, slope cutting, excavation, loading, transportation, loading/unloading of materials and operation of construction equipment etc. The vibrators used for concreting also produce noise. The amplified noise levels will be temporary in nature and easily mitigated. At most of the construction sites, there are no major sensitive receptors except for some native reptiles that may inhabit the proposed sites	Enhanced noise levels could be prevented and mitigated by careful planning of machinery operations, use of low noise equipment and scheduling of operations only during the daytime in order to reduce these levels. Though the impact of noise may be of temporary nature, the following measures shall be considered and implemented: Construction contract will clearly specify the use of equipment emitting noise of not greater than 85 dB (A) for the eight hour operation shift; High noise emitting equipment if any will be fitted with noise reduction devices such as mufflers and silencers wherever possible; For protection of construction workers, earplugs will be provided to those working very close to the noise generating machinery; High noise emitting equipment if any will be used during regular working hours so as to reduce the potential of creating a noise nuisance during the night; Slope Cutting activity will be carried out during fixed hours (preferably during mid-day). The timing should be made known to all the people within 500m from the site in all directions; Regular inspection and maintenance of the construction vehicles and equipment will be carried out; Replacement of worn out and noise producing parts of construction machinery will be timely done; and In case of severe noise, sound barriers will be used to avoid dispersion of sound waves into the nearby community The implementation of the above measures will generate impacts of low significance

Socio-economic Impacts	The construction activity would involve people of labor class frequenting the area for the entire length of construction period. The surrounding residential area is inhabited by people who associate very closely with a certain set of cultural values. The area being a part of a rural setup, it is quite uncommon for residents to experience and easily adjust to the presence of outsiders in their areas for any length of time. The significance of the impact is considered to be moderate	By adopting following measures, impact would be finally of low significance: In case, people from outside the area are engaged in the construction or operation of the project activities, this might result in cultural conflict with the local communities. Therefore, it is imperative to engage local work force as much as possible, and also develop and implement a strong community communication and participation plan; The contractor will be liable to engage at least 50% of its required (unskilled) labor force from within or around the project area; and It is highly recommended that the project proponent includes some CSR measures specifically for the tail-end population
Health & Safety	Various activities during the construction phase of the project could have health & safety impacts on workers and the people living in the nearby vicinity. The activities such as loading and unloading of excavated soil and construction material will be expected during the construction phase of the project. Workers safety would be at risk if they are not adequately trained. The impact on worker safety will be direct and of moderate significance. During the construction of sub and superstructure, activities such as fabrication, installation of formwork, installation of scaffoldings could have serious safety risks to the workers. The use of heavy machinery and vehicle is expected during the excavation and transportation activities. The safety of workers is of prime concern while dealing with such machineries and vehicles. The probability of such accident at project site is low but the significance might be of moderate nature	By adopting the following measures, the impact would be finally of low significance: Usage of heavy machinery will be planned carefully and only skilled persons will be allowed to operate the equipment; Provisions of proper signboards and informing the local people about the activity will be important. In addition, personal protection equipment such as helmets, gloves, dust masks, boots and earmuffs etc. will be provided for the workers; Adequate water supply and sanitation facilities will be provided in the labor camps; Caution signboards for the road users and surrounding people will be provided to avoid any accidents at the work site; In case of traffic diversions, proper signboards will be provided sufficiently ahead of the work site; and First aid facility should be in place and an ambulance should be available at site for 24 hrs.

Impacts During Operation and Maintenance Phase		
Breaching of Dam, Canal, Distributaries and Structures	Breach of dam and canal will threat system sustainability and following factors may also fuel the process. Improper operation of water control facilities; Deterioration of free board due to cattle trespass and other factors; Tampering of outlets; Canal siltation; Action of borrowing animals such as rats and porcupines; Inadequate supervision; Lack of timely and adequate repairs; and Lack of coverage of hydraulic gradient	BIPD-district level step (Irrigation Department) to monitor the system regularly; The important facilities that need attention and annual maintenance are canal embankments, falls and control structures and bed levels which are affected by siltation or scour. Canal section has been designed to ensure safety by following the standard design principals to design the banks against piping. In addition, all nullah crossings have been provided with Cross-drainage structures of at least 40 years return period flood capacity with adequate freeboard. For major nullahs, canal syphons have been provided so that nullah flows unhindered and therefore does not cause damage to the Canals; Include Capacity building of the communities in the O&M activities; Liaise with the communities to identify potential weaknesses in the system that could cause breaches; Ensure that the canal brick lining is regularly monitored to avoid any cracking impact from weathering; The flood protection spurs will be regularly checked to undertake any prone damage; Repairs on urgent basis; and Emergency response plan for Dam and Canal breach shall be followed, which is discussed in The EIA Report of Siri Toi Dam. Above measures will step down the significance of impact from high to low

Use of Irrigation Water for Drinking Purposes	Most of the locales in the project area are devoid of piped water supply. With availability of sweet water in the canal, there will be a tendency to use it for potable purposes as well. However, this may lead to health-related issues. This impact would be of moderate significance	Train local community on safe drinking water; Coordinate with TMA/ DC Zhob to install small filter plants at suitable locations for potable water; Install warning and information signs about dangers of using irrigation water for potable purposes; TMA / DC Zhob to assure potable Water quality as per WHO/ GOP standards; Turbidity and free residual chlorine tests shall be regularly performed; Arsenic will be tested as per WHO/GOP standards; and Keep continuous check on the site through employing security professional to check and shun the water usage by local public. Above measures will step down the significance of impact from moderate to low
Enhanced / Induced Use of Fertilizers and Pesticides	With additional area under cultivation, and with better water availability for existing area, cropping intensity will increase, resulting in an automatic increase of fertilizers and pesticides use. Use of any banned fertilizer and pesticide will cause health issues. It may also cause contamination of fresh water through surface runoff. This would be an impact of high significance	By adopting the following measures, the impact would be finally of low significance: Concerted efforts by the department of agriculture to disseminate information regarding sustainable use of fertilizers will help in keeping the use at an optimal level; Ammonium Nitrate (AN) and Calcium Ammonium Nitrate (CAN) fertilizers will not be allowed; and Use of restricted pesticides identified by WHO shall not be allowed. The list of restricted pesticides is provided in the EIA Report of Siri Toi Dam.

Periodic Cleaning and Maintenance of the System	The blessing of any available resource might be wiped out by poor governance. Non-functional water use associations, leakage, improper maintenance of structure, broken outlets, and poorly maintained field channels may result in unequal utilization of water. This impact would be a high significant impact	By adopting the following measures, the impact would be finally of low significance: The proposed project is an integrated irrigation program. The proponent will also facilitate it to become an integrated community development program through formal structure of SC and through the community engagement cell. Timely and correct sharing of information will enable other line departments to implement their own development schemes in the area; The BIPD will develop and implement a proactive maintenance plan for the proposed project, with predefined periodicity; Monitoring results; Ensure proper disposal of waste at designated landfill/disposal sites; and Efficiency of the system will be at its best by adopting proper maintenance activities such as silt removal and bed scratching at periodic intervals

9.6 Environmental Management Plan

302. The EMP is a strategic approach towards the effective implementation of the mitigation measures and environmental protection of the Project Area and its surroundings. This EMP ensures that the undue or reasonably adverse impacts of a project are prevented and the positive benefits of the project are enhanced. According to this plan, all the activities related to various phases of the project are controlled and monitored.

9.6.1 Structure of EMP

303. The contents of this chapter are given below:

- Purpose & Need of the EMP
- Objectives of the EMP
- Scope of the EMP
- Environmental Management Plan
- Implementation of EMP
- Stakeholder Coordination
- Trainings
- Communication & Documentation
- Institutional Arrangement for Implementation of EMP
- Institutional Arrangement for Implementation of EMP during Construction Phase
- Institutional Arrangement for Implementation of EMP during Operation Phase
- Grievance Redressal Mechanism (GRM)
- Environmental Management Cost

9.6.2 Objectives of the EMP

304. The main objectives of the EMP during different phases of the project is to implement mitigation measures and to evaluate the effectiveness of mitigation measures as proposed in the IEE and recommend improvement if any need would arise.

9.6.3 Scope of the EMP

305. The scope of the EMP includes the following phases of the project:

- Design Phase
- Construction Phase; and
- Operation Phase.

306. All the activities performed during these phases will be controlled and monitored according to this EMP

9.7 Environmental Mitigation Plan

307. Potential impacts and their mitigation measures are devised against the project activities to minimize their significance. Responsibilities for the collection and analysis of data as well as the reporting requirements have been outlined in Table 36. Implementation of environmental impact mitigation measures during construction is to avoid and reduce short- and long-term potential environmental impacts. Incorporation of environmental impact mitigation considerations into the tender and contract documents is a fundamental pre-requisite for effective implementation of the EMP

Table 39 - Environmental Mitigation Plan

Activity	Potential Impact	Mitigation Measures	Implementation Indicators	Party(ies) Responsible for Implementation
Construction Of Dam, Main Canal, Distributaries & Minor And Irrigation Structures				
A. Design & Planning Phase				
Assessment of water availability	Failure of design	Irrigation department to ensure proper data and design is implemented	Approval from BIPD before project operation	BIPD
Water rights issues in the area	Social issues	Proper water distribution through warabandi system, engaging water user associations and Irrigation department. Warabandi system is a rotational method for distribution of irrigation water, with fixed time allocations based on the size of landholdings of individual water users within a watercourse command area. It presupposes an overall shortage of the water supply. The primary objective of the method is to distribute this restricted supply in an equitable manner over a large command area.	Design report will clearly indicate water rights areas and water allocation. Subsequent development of Chakbandi (command area mapping for each tertiary watercourse) which is in progress by Irrigation Department clearly identifies water rights holders and size of their lands Open access to Warabandi list and its implementation schedule to ensure fairness in water distribution, i.e. each farmer gets entitled share in hours per week	Revenue Department, Zhob Water User Associations Irrigation Department, District Level
Public disclosure of final design	Social issues	Continued stakeholder engagement and timely public disclosure.	Minutes of meetings of stakeholder's consultation	Design Consultants Irrigation Department, District Level
Coordination with all relevant departments for NOCs	Delay in project implementation &cost overruns	Continued stakeholder engagement and proper coordination with relevant departments for timely approvals.	NOCs from relevant departments	Design consultants Irrigation Departments, District Level
B. Implementation & Construction Phase				

Activity	Potential Impact	Mitigation Measures	Implementation Indicators	Party(ies) Responsible for Implementation
Continued stakeholder engagement	Social issues	Proponents to establish an environmental & social cell responsible for stakeholder engagement and timely information dissemination	Minutes of meetings of stakeholder's consultation Dissemination material	Contractor ESMMC
Construction contractor mobilization and establishment of campsite and machinery/ equipment Yard	Changes in land use pattern Influx of external work force Social conflicts	Select campsite in view of the cultural norms of the area to avoid undue interference of the Construction contractor's staff with the local residents. Approval of campsite will be taken as per attached approval form in the EIA Report of Siri Toi Dam. Give priority employment to local residents. The land shall be rented for the camp site and equipment yard.	Monthly rent receipts. Development & implementation of policy on local employments Employment record	Construction Contractor Monitoring by Supervision Consultant and Reporting to ESMMC
	Workshop facilities may spread oils & chemicals	Disposal of used oil and chemical waste in accordance with MSDS. Efficient Use of Chemicals. Good housekeeping practices at workshop areas. Mixing of waste into fresh water sources shall not be allowed.	Visual inspection	Construction Contractor Monitoring by Supervision Consultant and Reporting to ESMMC
	Deterioration of air quality due to machinery & equipment	Proper engine tuning of machinery/ equipment to meet National Environmental Quality Standards of Pakistan limits for air quality (discussed in the EIA Report of Siri Toi Dam) Water should be sprinkled where needed and appropriate, particularly if the campsite is near the communities.	Monitoring shall be done on stack of machinery and equipment. The parameters required to be monitored are Smoke, SOx, CO, VOCs and NOx. Evidence of measurement records.	Construction Contractor Monitoring by Supervision Consultant and Reporting to ESMMC

Activity	Potential Impact	Mitigation Measures	Implementation Indicators	Party(ies) Responsible for Implementation
	Noise	Noise reduction devices on high noise equipment Regular inspection, maintenance and lubrication of the construction vehicle and equipment Use of PPEs by the workers Avoid night time activity	Monitoring compliance to NEQS (discussed in the EIA Report of Siri Toi Dam) for noise (SRO 72 (KE) / 2009) The sampling shall be done twice on monthly basis at 7m distance from the source. The duration of sampling shall be 24 hours @ 15 seconds interval over 15 minutes every hour (averaged)	Construction Contractor Monitoring by Supervision Consultant and Reporting to ESMMC
	Land degradation due to solid waste disposal of camp site	Ensure proper disposal of camp site waste at designated disposal sites according to waste management plan attached in the EIA Report of Siri Toi Dam. An impervious liner shall be laid to waste sites before the dumping of solid waste. The approval for impervious liner shall be granted by Supervision Consultant on a form attached in the EIA Report of Siri Toi Dam. Good housekeeping practices within the camp site. Disposal of campsite waste near residential colonies or in agricultural fields shall not be allowed.	Visual inspection	Execution by Construction Contractor Monitoring by Supervision Consultant and EMMP implementation reporting to ESMMC

Activity	Potential Impact	Mitigation Measures	Implementation Indicators	Party(ies) Responsible for Implementation
	Water contamination	Proper sewerage disposal arrangements to be provided such as septic tank and soaking pits for camps.	Monitoring compliance to NEQS (discussed in the EIA Report of Siri Toi Dam) of sanitary wastewater generated from Camp Site. Waste management plan in place Photographic record	Construction Contractor Monitoring by Supervision Consultant and EMMP implementation reporting to ESMMC
	Health and Safety issues	Protective fencing around the camps. Firefighting equipment at the camps. Firefighting training to the camp staff. First aid facility should be in place. Safety precautions shall be taken to transport, handle and store hazardous substances. Contractor to prepare OHS plan and get it approved by Supervision Consultant.	Use of personal protective equipment Health & safety plan in place	Construction Contractor Monitoring by Supervision Consultant and reporting to ESMMC.
Transportation of construction material	Soil erosion and contamination	Avoid vehicular traffic on unpaved roads as far as possible. Vehicles and equipment shall not be repaired in the field and all the repairing work will be done at designated workshop facilities. Construction material should be covered while transportation. If unavoidable, impervious sheathing shall be used to avoid soil and water contamination.	Log of vehicle and equipment repairs	Construction Contractor Monitoring by Supervision Consultant and reporting to ESMMC.

Activity	Potential Impact	Mitigation Measures	Implementation Indicators	Party(ies) Responsible for Implementation
	Air pollution	Minimize operation of vehicles and machinery close to the water channels, water reservoir. Vehicles shall be kept in good working condition and properly tuned, in order to minimize the exhaust emissions	Route maps of vehicle movement Log of vehicle maintenance	Construction Contractor Monitoring by Supervision Consultant and reporting to ESMMC.
	Noise pollution	Vehicles to have exhaust mufflers (silencers) Nighttime traffic shall be avoided near the communities. Inform local population beforehand if nighttime traffic is unavoidable.	Log of vehicle movement time Visual inspections of the vehicles	Construction Contractor Monitoring by Supervision Consultant and reporting to ESMMC.
	Health and Safety issues	Road signage fixed at appropriate locations Train all drivers on defensive driving Low vehicle speeds 15 km/hr near / within the communities.	Visual inspections Training record	Construction Contractor Monitoring by Supervision Consultant and reporting to ESMMC.
Excavation, backfilling and compaction works	Soil erosion	Prepare material borrowing and disposal plan Avoid cultivation fields for borrowing material to the extent possible Obtain written consent of the land owner for material (soil) borrowing Keep photographic record (before, during, after) for borrow and disposal areas. Leveling of borrow sites.	Evidence of plan in place. Photographic record	Construction Contractor Monitoring by Supervision Consultant and reporting to ESMMC.

Activity	Potential Impact	Mitigation Measures	Implementation Indicators	Party(ies) Responsible for Implementation
	Site overburden	Consider wind direction while selecting sites for stock piles. Keep Stockpiles of overburden covered. Ensure proper disposal of construction waste at designated disposal sites. Take approval for selection of solid waste disposal site if landfill is not available from Supervision Consultant on the form attached in the EIA Report of Siri Toi Dam. An impervious liner shall be laid to waste sites before the dumping of solid waste. The approval for impervious liner shall be granted by supervision consultant on a form attached in the EIA Report of Siri Toi Dam. Dismantled asphalt pavement shall be dumped to the waste site.	Visual inspections Monitoring Particulate Matter PM_{10}	Construction Contractor Monitoring by Supervision Consultant and reporting to ESMMC.
	Borrow pit	As far as possible wasteland or natural areas with a high elevation will be demarcated for borrowing earth material. Strip and stockpile the top 300 mm of the plough layer for redressing the land where the use of agriculture land is unavoidable. Where deep ditching is to be carried out, the top 1 m layer of ditching area will be stripped and stockpiled. The ditch will be initially filled with scrap material from construction and then leveled with the stockpiled topsoil. Ditches or borrow pits that cannot be fully rehabilitated will be landscaped. Land owners will be compensated according to the terms of lease agreement. The approval forms are attached in the EIA Report of Siri Toi Dam.	Monthly rent receipts.	Construction Contractor Monitoring by Supervision Consultant and reporting to ESMMC.

Activity	Potential Impact	Mitigation Measures	Implementation Indicators	Party(ies) Responsible for Implementation
	Sites of Historical, Cultural, Archeological or Religious Significance	Proponent and the Supervision Consultant to ensure that the construction staff is educated about the location and importance of the cultural sites that exist in the Project Area. Contractor to ensure that these sites are not affected by the construction related activities. These aspects will be included in the trainings to be conducted for the contractor's staff. Stop the work immediately in case of chance find of any sites or artifacts of historical, cultural, archeological or religious significance. Chance Find Procedure, attached as in the EIA Report of Siri Toi Dam, and Antiquities Act 1975 should be followed. No disturbance to Graveyards during the construction activities.	Evidence of training provided to contractor staff. Evidence of maps in place with these sites shown. Records of appropriate action taken in case of chance find. Photographic record of chance find	Construction Contractor Monitoring by Supervision Consultant and reporting to ESMMC.
	Noise pollution	Noise reduction devices on high noise equipment Regular inspection, maintenance and lubrication of the construction vehicle and equipment Use of PPEs by the workers Avoid night time activity	Monitoring compliance to NEQS (Appendix-5) in Main environmental Report for noise (SRO 72 (KE) / 2009) The sampling shall be done twice on monthly basis at 7m distance from the source. The duration of sampling shall be 24 hours @ 15 seconds interval over 15 minutes every hour (averaged)	Construction Contractor Monitoring by Supervision Consultant and reporting to ESMMC.

Activity	Potential Impact	Mitigation Measures	Implementation Indicators	Party(ies) Responsible for Implementation
	Air pollution	Proper engine tuning of machinery/ equipment to meet National Environmental Quality Standards of Pakistan limits shall be ensured. NEQS for ambient air quality is attached as Appendix-5 in Main environmental Report. Water should be sprinkled where needed and appropriate, particularly at work sites near the communities.	Monitoring shall be done on stack of machinery and equipment. The parameters required to be monitored are Smoke, H_2S, SOx, CO, VOCs and NOx. Evidence of measurement records.	Construction Contractor Monitoring by Supervision Consultant and reporting to ESMMC.
	Health and Safety issues	Demarcation tapes to be installed around the construction site to avoid any unauthorized entry Personal protective equipment should be made available at site and the usage of the PPEs should be ensured. Health & safety plan should be prepared by contractor and get it approved by Supervision Consultant	Use of personal protective equipment Health & safety plan in place	Construction Contractor Monitoring by Supervision Consultant and reporting to ESMMC.
C. Operation & Maintenance Phase				
Breaching of dam, canal, distributaries and structures	System sustainability	BIPD to monitor the system regularly. Include Capacity building of the communities in the O&M activities. Liaise with the communities to identify potential weaknesses in the system that could cause breaches. Emergency response plan for canal breach shall be followed, which is attached **in the EIA Report of Siri Toi Dam.**	Monitoring reports Visual Inspection	District Level Irrigation Departments ESMMC

Activity	Potential Impact	Mitigation Measures	Implementation Indicators	Party(ies) Responsible for Implementation
Use of irrigation water for drinking purposes	Health issues Social issues	Train local community on safe drinking water Coordinate with TMA to install small filter plants at suitable locations for potable water Put warning and information sings about dangers of using irrigation water for potable purposes TMA to assure potable Water quality as per WHO/ GOP standards. Turbidity and free residual chlorine tests shall be regularly performed. Arsenic will be tested as per WHO/GOP standards.	WHO/ GOP Drinking Water Standards	Construction Contractor Monitoring by Supervision Consultant and reporting to ESMMC.
Use of Fertilizer & Pesticides	Banned fertilizer and pesticides will cause health issues Contamination of fresh water through surface runoff	Ammonium Nitrate (AN) and Calcium Ammonium Nitrate (CAN) fertilizers will not be allowed Use of restricted pesticides identified by WHO shall not be allowed Proper drainage system	Visual inspection Monitoring records Market survey for availability of AN and CAN fertilizers	Agriculture Departments District Level ESMMC
Periodic cleaning and maintenance of the system	Solid waste generation	Ensure proper disposal of waste at designated landfill/disposal sites.	Visual inspection	Irrigation Departments District Level Water User Association
Community Participation for management and operation of the irrigation system	Social issues System sustainability	Ensure community participation in management and operation of the irrigation system Training of community	Training records Community participation records	Irrigation Departments District Level Water User Association

10 PROJECT CONSTRUCTION

10.1 General

308. The Siri Toi Dam project consists of following works:

- Main Dam, 66 m high from river bed and about 231-m wide
- One saddle dam or dyke varies in height from 20 to 35 m and total length of 234 m.
- More than 40 km of main irrigation channel and about 15 km of secondary channel.
- 1.6 Km long outlet steel conduits properly anchored with concrete pedestals.
- 135 m wide ogee spillway
- More than 130 structures including fall and Aqueducts.

309. It is estimated that the above work can be completed within 36 months from its start on 1st January 2019.

10.2 Characteristics of Construction Site

310. The site is conveniently located from construction point of view as the required construction materials are available in the vicinity and the main highways provide access to them. There is substantial perennial base flow in the river bed. Ground water therefore can be tapped by excavating shallow pits or through pumping at the Dam site. Alternatively temporary generator system may be established during construction stage. Unskilled labor is available from nearby villages, while skilled labor can be hired from Zhob or D I Khan.

10.3 Access

311. There exists a both black top roads and fair weather shingle road up to the Dam site from Zhob. The road needs improvement as a whole especially at river / nullah crossings. It is desirable that last few Km of road from dam site be converted into an asphalted road so that this can be used as a permanent assess road for operation and maintenance of Dam and related works. This road will also facilitate the project contractor to mobilize plants, equipment, construction machinery and material to the project site.

10.4 Construction Camp and Facilities

312. For construction of Dam and appurtenant works construction camps and temporary production facilities base can be located in the vicinity of the Dam site, stone quarries etc. Major works on the project will be carried out from right flank. Concrete processing plants can be located either on right bank or on some high ground on upstream or downstream of Dam. For Construction of Canal Works, same camp and facilities can best be used. However moveable filed offices can be shifted to place to place during progress of work.

10.5 Availability of Construction Materials / Equipment

313. For construction of Dam and appurtenant works under construction materials such as fine and coarse aggregates are available in the near vicinity of the Dam site. Stone crushing and processing plant will however be required to be installed at the site for producing concrete aggregate. River alluvium may also be used as aggregate in making concrete but would require processing to achieve proper gradation.

314. Water required for construction can be obtained from the river or by abstraction through wells. Groundwater has to be checked for SAR and necessary cement should be used accordingly. Cement is supposed to be procured from, D.I. Khan. Most of the other construction supplies such as fuel, steel and lubricants can also be arranged from Quetta or D.I. Khan. Construction materials such as rolled steel members, ordinary metal structures, timber, lumber, pumps and transmission line instruments, insulation material, instruments to be installed in the Dam body need to be brought from other areas of Balochistan or bring from Karachi. Heavy construction equipment and machinery including tower cranes and concrete batching plants may be available in Karachi on rental basis or otherwise have to be imported from western countries or Japan.

10.6 Participation of Local Contractors

315. There are a few local contractors in Balochistan who have experience of working on large highway projects, small dams and buildings and housing schemes. These construction firms possess construction equipment manufactured by Japan, Italy and USA and can come forward and participate the construction of works in this project. These construction firms may form joint ventures to overcome their deficiencies such as lack of experience in construction of big dams, concrete structures, foundation preparation including grouting, handling river diversion etc.

10.7 Major Quantities of Work

316. Quantities of various items of works involved in the construction of Siri Toi Dam have been worked out from drawings prepared based on detailed design of each project component.

10.8 Construction Schedule

317. Works at Dam involve construction of 231 m long and nearly 66 m high earthfill Dam with clay core. One saddle dam/dyke 234 m long varying in height of 20-32 m. Outlet works with steel conduit about 1500 m, 135 m wide concrete ogee spillway with concrete chute and about 44,800 m long Irrigation canal system with structures.

318. The Project Works are divided accordingly in the following four main activities.

- Activity–1: Pre-Construction Activities - include: land acquisition, review of design and tender documents and award of contract.
- Activity–2: Preliminary Works include improvement of existing access road to Dam site, construction of offices, material testing laboratory, mobilization of construction equipment, etc.
- Activity–3: Construction of Dam and Appurtenant works. (Include construction of diversion channel, cofferdams, grouting, foundation excavations and instrumentation
- Activity–4: Construction of Spillway and Outlet works.
- Activity–5: Irrigation Canal System Includes main canal and crossing structures.

10.9 Construction of Dam And Appurtenant Works

a) General

319. The meteorological and river flow data show that the best suited period for construction is from September to end January next year. During this period river flows are low and interruptions in the construction activities due to rain will be less frequent. Construction work

may however continue with some interruptions in March to November each year. Values of monthly rainfall based on recorded data at Zhob is shown in Table 3 and Table 4 shows river flows (average monthly values) based on estimated flows of Siri Toi river at the proposed Dam site. In formulating the construction schedule it has been assumed that the contract will be awarded by 5th January of 2019, year – 1

320. Main factors which affect the construction programme are planning for material utilization and the proposed scheme for diverting river flows during construction. In view of the work load involved the construction of the Dam and related works have been proposed to be completed in a period of 20 months (beyond preconstruction and preparatory works) involving two main flood period. The river flows are proposed to be diverted through a diversion channel which is aligned through left flank of the river.

321. For economical construction, material obtained from the required overburden excavation of dam and spillway will be used in constructing the diversion channel and coffer dams.

b) Proposed Construction Schedule

322. The proposed construction schedule shown in Figure 41. It indicates all construction activities during the project. The spillway, outlet structure and main Dam to proceed simultaneously so as to achieve coordinated progress permitting direct placement of excavated martial from the spillway, outlet works main Dam foundation to avoid double handling as far as possible.

323. The year to year construction activities shows in the construction programme are as described below.

Construction Year – 1

(i) Mobilization

324. Mobilization for this project will include the logistics of assembling all the necessary plant and construction equipment, providing housing facilities with water sanitary and power utilities, training and organizing the work forces and getting the construction work underway. It is important that all works discussed under preconstruction activities including improvement works for the existing access road are completed prior to the award of contract for the construction of the Dam and related works. The period for pre-construction activities and preparatory works will extend over the first 6 months of the contract, viz. January to June in year – 1.

(ii) Diversion Channel and Coffer Dams

325. The work on excavation and stone lining of diversion channel will be taken up in the month of June just before the start of main flood period. It is expected that the channel will be excavated by end of August of year – 1. Work on the construction of upstream and downstream coffer dams will be taken up in August and September of year – 1 and completed in 2 months' time by the start of October. The river flows will now be diverted through the diversion channel thus making the main two third of Dam area ready for taking up the construction. The 25-year return period flood is 605 cumecs. The diversion works and coffer dam height will be carried out for this design discharge.

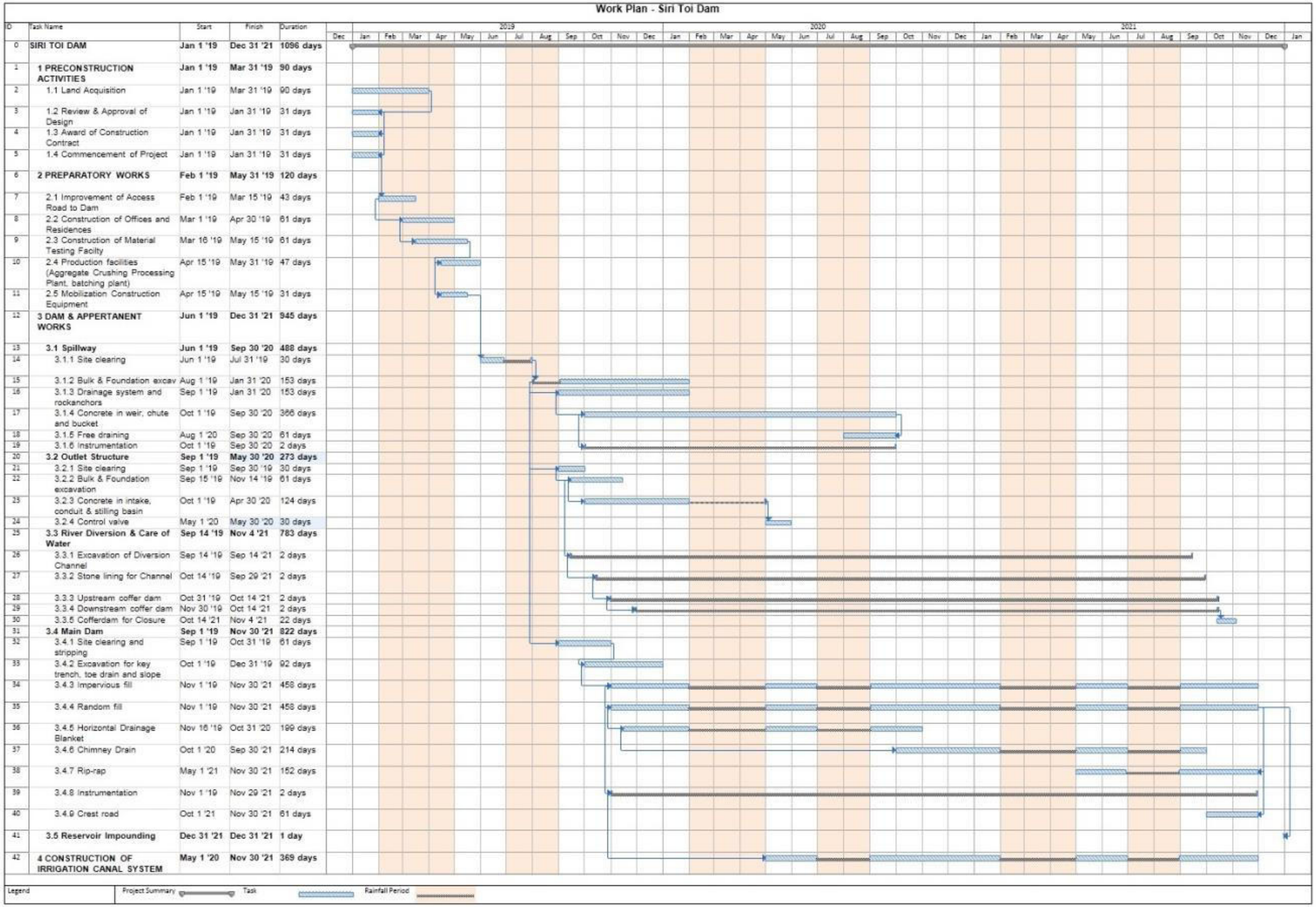

Figure 41 - Construction Activity Flow Chart

Construction Year – 2

326. The work on major construction activity of main Dam will be resumed and completed during the construction year – 2. The river flows will continue to pass through the diversion channel. After the construction of 65% of Dam by the end of second year when the spillway will be gaining substantial completion stage; the main closure section of dam can be planned. Water will be diverted towards intake structure and outlet then the work on remaining portion of Dam will be started in October of 2nd year on double shift basis and will be completed within 3 months.

(i) Spillway

327. This work can be started immediately after mobilization of contractor and completion of pre-construction activities. Foundation excavation for the spillway structure will be taken up in June and July and can continue with other activities such as preparation for concrete and foundation drainage. It is proposed that construction of complete spillway and all associated structures such as stilling basin and retaining walls will be completed by the end of 2nd year of construction.

(ii) Outlet works including Steel Pipe

328. The work on the intake structure and outlet steel pipe through dam will be started simultaneously and will be completed in February in the 2nd year of construction. It is needed therefore that both of these will complete together so that in case of any unusual flow in the river some after construction of the closure section water can be passed through it without much damage during 2nd Year.

c) Construction of Irrigation Networks

329. Works proposed for construction of the irrigation system may be awarded to the contractor under a separate contract package; with a view to beneficially use available water from Siri Toi Dam. It is important that the proposed irrigation works are also completed along with the construction of Dam. These works can be taken up in January of Construction year – 2 and completed in a period of 24 months by December of 3rd year. The construction of drainage crossing and fall structures may take relatively more time than irrigation canals, therefore it is recommended that after layout of complete irrigation system on the ground the construction of structure can be started soon.

11 PROJECT COST AND ECONOMIC ANALYSIS

11.1 Basis of Cost Estimates

330. The cost estimate is prepared using feasibility grade design/drawing, fairly accurate estimates of quantities of various item were worked out. Bill of quantities for various items of works was then transformed into Engineer's Estimates by insertion of Unit Rates. The rates of different items were selected keeping in view:

- Balochistan schedule of rate 1998 with updated premium for escalation.
- Current market prices
- Bid prices from recently completed projects
- Degree of difficulty in mobilizing and operating under policies consideration of sub-project site.
- Availability of labor and materials for use in construction

331. Once the unit rates were decided, the cost estimates were computed for various components of sub-project. Costs for non-structural measures such as environment, social and capacity building etc. were added to infrastructure costs for arriving at the total cost. A summary of estimated cost (Rs: 5445 Million) for this sub-project is given in.

332. Table 40 - Cost Estimate – Siri Toi Dam Sub-Project.

Table 40 - Cost Estimate – Siri Toi Dam Sub-Project

No.	TITLE	AMOUNT
1	MAIN DAM	1,085,060,000
2	DYKE	512,460,000
3	SPILLWAY	1,168,405,000
4	INTAKE STRUCTURE AND OUTLET WORKS	600,609,500
5	MAIN CANAL	889,331,500
6	OFFTAKE STRUCTURE (31 No)	7,473,000
7	FALL STRUCTURE (98 No.)	20,764,000
8	AQUEDUCT (9 No)	272,356,200
9	SIPHON (3 No)	87,847,000
10	DRAINAGE CULVERT (5 No)	2,812,000
11	ROAD CULVERT (2 No)	23,007,500
12	WASHING STRUCTURE (5 No)	1,392,760
13	CATTLE DRINKING TROUGH (5 No)	225,900
14	DRINKING WATER SUPPLY	8,750,000
TOTAL 1 TO 14		4,742,906,015
GRAND TOTAL		**4,742,906,015**

333. In addition to the Infrastructure Costs, the proposed development cost includes the following components also;

- Command Area Development — Rs. 416.60 Million
- Watershed Management & Groundwater Recharge — Rs. 270.50 Million
- Khushkaba Area Development — Rs. 14.99 Million

334. Accordingly, the total Development Cost is estimated to be Rs.5445 million.

Methodology and Data Inputs

11.1.1 Collection of baseline and potential data for design of scheme

335. Data on current cropping patterns and intensities, crop yields and by-products, and farm gate prices have been collected while conducting three surveys: a) interactive group dialogues at the scheme level using a pre-tested checklist; b) semi-structured interview from population of households (100% households) for wealth indicators and assets; and c) semi-structured interviews using a sample size of 25% of total households for socio-economic baseline.

11.1.2 Cropping intensity

336. For the command areas of Perennial irrigation system the design cropping intensity is 120%. The particulars of design cropping intensity in the command area of Perennial irrigation system are: a) Rabi Crop – 44% copping intensity; b) Kharif Crops – 56% cropping intensity; and c) forest plants, including arid fruits including Apple/Apricot– 20% cropping intensity. For the Khushkaba irrigation system the designed cropping intensity is 120%.

11.1.3 Crop inputs

337. Crop models developed for this scheme have the facility of adding the inputs like seed, fertilizers, chemicals, mechanized operations and labor requirements. These inputs are used for the calculation of crop budgets. The detail of these has been provided for each crop in the analysis.

11.1.4 Design cropping pattern and cropping intensity

338. An appropriate cropping pattern is essential for realizing the optimal benefits of investment made for the development of Khushkaba, and perennial irrigation commands of Siri Toi Storage Dam. Besides irrigation supplies, following agricultural factors have been considered for devising the cropping pattern and cropping intensities in an integrated scheme:

- Existing cropping pattern and intensities in the area;
- Agro-climatic conditions of the area;
- Availability of agriculture labor and farm machinery;
- Marketing and transportation infrastructure;
- Socio-economic conditions of the area; and
- Agriculture support services.

339. Government policies and priorities reflecting food and fiber requirements of country's population and international market were also analyzed. Water in the area is a limiting factor and with the design of perennial commands, farmers would be in a position to adopt promising cropping patterns and best practices for generating new livelihoods or enhancing the productivity of the existing livelihoods. The irrigation system is designed to divert water and considering the variability in water in wet and dry years, forestry and forages are included in the land use. Three land use systems are designed for the integrated scheme:

- ***Perennial irrigation command:*** for perennial irrigation system of Sir Toi Storage Dam having water allowance of perennial water. The current cropping intensity is 0%, which will increase to 120% in an average year in the perennial irrigation network. The command area is 9947 acres.
- ***Khushkaba farming system***: The current cropping intensity is almost zero, which will increase to 100% with the development of runoff water harvesting techniques. The target area is 361 ha.
- ***Watershed area:*** The current surface cover is largely of degraded bushes and patchy grasses, which will increase to 200% cropping intensity with the plantation of forest and arid fruit plants. As both the forest and fruit plants are perennial that's why cropping intensity is taken as 200%. The water harvesting system will be developed for a plant spacing of 20 x 20 feet. The target area.

340. In"without project" scenario there are no cropped area under perennial irrigation; whereas in the "with project" scenario about 4832 ha (11,935 acres) of command area will be designed using a cropping intensity of 120%. Design cropped area, cropping intensity and cropping pattern are presented in Table 40.

Table 41 - Design cropped area and cropping intensity for remodeling perennial irrigation command area of Siri Toi Storage Dam

Crops/Plants	Without Project		With Project	
	Cropped ha	Cropping Intensity	Cropped ha	Cropping Intensity
Plants (Fruit, Forest)				
Apple/Apricot	-	-	805[6]	20
Rabi Crops				
Wheat	-	-	966	24
Radish	-	-	806	20
Kharif Crops				
Kharif Pulses	-	-	806	20
Garlic	-	-	644	16
Kharif Vegetable	-	-	805	20
Total Cropped Area and Intensity				120
Command Area			**4,832**	

341. ***Increase in Khushkaba cropped area***: In the "without project" scenario there is nothing in the Khushkaba farming area. Almost all the households indicated the need for the development of runoff harvesting system. In the "with project" scenario, about 361 hectare (892 acres) of Khushkaba farming will be developed for a cropping intensity of 100%, with 10.5% under forest and arid fruit plants and grasses. Design cropped area and cropping intensity is presented in Table 42.

[6] *In economic and financial analysis benefits are taken for half of the cropped area in Perennial irrigation system*

Table 42 - Design cropped area and cropping intensity for the Khushkaba farming

Crops/Plants/Grasses	Without Project		With Project	
	Cropped (ha)	Cropping Intensity	Cropped (ha)	Cropping Intensity
Rabi Crops				
Barley	-	-	75	21
Cumin	-	-	75	21
Kharif Crops				
Maize	-	-	61	17
Sweet Melon			60	17
Pulses			60	17
Plants				
Arid Fruit Plants	-	-	30	8
Total Cropped Area and Intensity	-	-		100
Total Target Area	**-**	**-**	**361**	

342. ***Design surface cover and productivity of Watershed:*** In the "without project" scenario there is very sparse surface cover largely non-palatable species with very low cropping intensity and trees have become bushes due to the grazing pressure. Almost all the households indicated the need for development of water harvesting system for fuelwood, arid fruits, shrubs and grasses. In the "with project" scenario, about 3750 ha watershed will be developed.

.Table 43 - Design plantation and land use intensity assumptions for the Watershed area

Plants/Shrubs/Grasses	Without Project		With Project	
	Plantation Area	Cropping Intensity	Plantation Area	Cropping Intensity
Arid Fruits Plant	-	-	1500	200
Wild Ber (Jujuba)	-	-	1500	200
Acacia	-	-	750	200
Arid Fruits Plant	-	-		200
Grasses	-	-	3750	
Total Planted Area	**-**	**-**	7500[7]	200
Total Target Area	**-**	**-**	3750	200

343. ***Design crop and plant productivity:*** Crop and plant productivity assumptions have been developed for the four land use systems: a) Spate irrigation command area; b) perennial

[7] *In economic and financial analysis benefits are taken for 252 acres, as planted area is used.*

canal irrigation system; c) Khushkaba farming system; and d) watershed area. The initial yield and yield at full development are presented in Table 44 to Table 46.

Table 44 - Design crop and plant productivity for the perennial irrigation command area of Sir Toi Storage Dam'

Crops/Plants	Baseline Yield (kg/ha)	Yield at Full Development (kg/ha)	Year of Full Development
Plants (Fruit)			
Apple/Apricot	6000	13500	7
Rabi Crops			
Wheat – Grain	1975	3650	1
Vegetables		17800	1
Kharif Crops			
Kharif Pulses	600	1105	1
Garlic	7600	9500	1
Vegetables	9650	18500	1

Table 45 - Design crop and plant productivity for the Khushkaba farming system of Sir Toi Storage Dam:

Crops/Plants/Grasses	Baseline Yield (kg/ha)	Year at Full Development (kg/ha)	Year of Full Development
Rabi Crops			
Barley	-	2965	1
Cumin	-	1186	1
Kharif Crops			
Maize	-	2965	1
Sweet Melon		13000	1
Pulses		865	1
Plants			
Arid Fruit Plants – Falsa	-	4633	2
Total Area			

Table 46 - Design plant productivity for the Watershed area of Siri Toi Storage Dam' Package

Plants/Shrubs/Grasses Arid Fruits - Almonds	Baseline Yield (kg/ha)	Yield at Full Development (kg/ha)	Year of Full Development
Arid Fruits Plant	618	4633	4
Wild Ber (Jujuba)	1112	11367	4
Acacia	712	618	4
Grasses	2441	927	1

344. ***Marketing:*** Though the condition of existing marketing facilities is not good, yet they are adequate for the proposed increase in production. Excess wheat after deducting the household consumption or local sales and other crops are assumed to be sold through Commission Agents in Karachi and Quetta wholesale market. Fodders will be used for feeding of animals.

11.1.5 Benefits of Scheme and Analysis

345. ***Construction conversion factor***: A Construction Conversion Factor (CCF) was estimated as a part of the Feasibility Study of Sir Toi Storage Dam. The calculations were based on breaking down each element and a CCF, of 80% has been estimated for perennial and Spate irrigation schemes based on a breakdown of the components of construction costs, materials, labour, machinery & transport and others. The value of 79.5% is obtained from the calculations and rounded value of 80% is used in this analysis. The calculations of economic rates for steel and cement are presented in Annexure. A value of 85% is calculated for steel and 72% for cement (Table 46).

Table 47 - Derivation of construction correction factor

Item	% of Total Cost	Conversion Rate (%)
Steel	3.6	85
Cement	4.4	72
Unskilled labour	17.6	80
Skilled labour	12.5	100
Machinery & Transport	18.5	55
Others	43.6	90
Total	100	80

346. ***Labour assumptions***: Economic prices for labour are estimated from the shadow wage rate which reflects the opportunity cost of labour in the economy. The opportunity cost of the skilled labour is estimated to be 100% as the skilled labour is scarce in the economy and able to find jobs almost at the prevailing equal wage rates. Unskilled labour is always in surplus in the economy and there are no restrictions on the mobility of it. The shadow wage

rate for unskilled labour is also determined by the opportunity cost. The prevailing wage rate for unskilled labour is Rs 600/day in the scheme area for the common masonry work and Rs.1200/day in the Zhob city. Therefore the shadow wage rate/conversion rate is valued at 80% of the financial cost.

347. ***Machinery and transport***: The calculation of economic prices for machinery and transport are estimated for the selected schemes. The Import prices (CIF) are taken and taxes are added to these. The conversion rate for both is calculated as 55%.

348. ***Standard conversion factor***: The SCF is calculated from national statistics of imports, exports and rates of duties, taxes and subsidies to produce an overall estimate of the net distortion in the economy as a whole compared to an open market. This is applied to any items that do not have an individual economic price estimate. The SCF has been calculated for five years 2011-12 to 2015-16 using the following expression:

$$SCF = \frac{M + X}{(M + T_m)(X - T_x)}$$

Where: M is the CIF values of imports
X is the FOB values of exports
Tm is the net value of taxed/subsidies on import
Tx is the net value of taxes/subsidies on export.

11.1.6 Financial Prices of Project – GVP, Farm Cost and NVP

349. ***Financial prices of project GVP, farm cost and NVP under "with project" scenario:*** The financial prices of GVP, farm cost and NVP under "with project" scenario for the perennial irrigation, Khushkaba farming area are presented in Table 47 to Table 49 respectively.

Table 48 - Project GVP, farm cost and NVP under "with project" scenario for perennial irrigation command area (Financial Prices) of Siri Toi Storage Dam

Crops	Area (hectare)	GVP (per ha)	Financial Prices (million Rs.)		
			GVP	Farm Cost	NVP
Orchards					
Apple/Apricot	805	0.608	488.95	38.03	451
Rabi Crops					
Wheat	966	0.17	167.56	35.34	132
Rabi Vegetable	806	0.53	430.08	82.93	347
Kharif Crops	0				
Kharif Pulses	806	0.09	75.65	31.51	44
Garlic	644	0.75	483	93.87	389.13
Kharif Vegetable	805	0.634	510.37	69.76	440.61
Total	**4832**		**2,101**	**296**	**1,805**

Table 49 - Project GVP, farm cost and NVP under "with project" scenario for Khushkaba target area (Financial Prices) of Siri Toi Storage Dam

Crops	Area (hectare)	Financial Prices (million Rs.)			
		GVP (per ha)	GVP	Farm Cost	NVP
Plants (Fruit, Forest)					
Arid Fruits Plant	25	0.17	4.25	0.20	4.05
Rabi crops					
Barley	72	0.07	4.76	1.63	3.13
Cumin	47	0.19	9.07	0.75	8.32
Kharif Crops					
Maize	83	0.05	3.94	0.33	3.61
Sweet Melon	65	0.20	13.25	0.65	12.60
Pulses	69	0.09	6.44	0.76	5.68
Total	**361**		**41.7**	**4.3**	**37.4**

11.1.7 Scheme Benefits

Agriculture and Watershed Benefits:

- Perennial irrigation commands of Siri Toi Storage Dam
- Khushkaba farming system
- Watershed management and groundwater recharge
- Small scale solar power drip irrigation orchards around the periphery of the ponds and reservoir
- Gender Water Development – Economic Development Interventions

350. Keeping in view the above-mentioned land use patterns, design cropping pattern, land use practices and productivity have been used to estimate agriculture and watershed benefits in Tables from Table 50 to Table 50.

351. . Financial and economic gross margins with or without project scenarios are determined. The increase in cropped area productivity with project shows significant increase in financial and economic returns. Increase in yield of fodder, crop residues and capacity building in silage would significantly increase livestock productivity. Reservoirs/ponds have been designed in the Khushkaba and watershed areas for multiple water uses. Increase in productivity of livestock to the extent of 50% is expected from increased fodders, forages and farm wastes. These benefits are assumed for the existing number of livestock. Financial and economic gross margins for the four land use pattern are presented in Table 50 to Table 50.

Table 50 - Incremental Benefits – Perennial irrigation command area of Siri Toi Storage Dam

Year	Without Project (million Rs.)			With Project (million Rs.)		
	Benefit	Net Farm Cost	Net Value of Production	Benefit	Net Farm Cost	Net Value of Production
1	0.00	0.00	0.00	184.49	51.52	132.97
2	0.00	0.00	0.00	446.05	86.49	359.56
3	0.00	0.00	0.00	877.53	150.62	726.91
4	0.00	0.00	0.00	1188.75	183.34	1005.41
5	0.00	0.00	0.00	1642.59	237.41	1405.18
6	0.00	0.00	0.00	2100.94	296.19	1804.75
7	0.00	0.00	0.00	2100.94	296.19	1804.75
8	0.00	0.00	0.00	2100.94	296.19	1804.75
9	0.00	0.00	0.00	2100.94	296.19	1804.75
10	0.00	0.00	0.00	2100.94	296.19	1804.75
11	0.00	0.00	0.00	2100.94	296.19	1804.75
12	0.00	0.00	0.00	2100.94	296.19	1804.75

Table 51 - Incremental Benefits – Khushkaba farming system of Siri Toi Storage Dam

Year	Without Project (million Rs.)			With Project (million Rs.)		
	Benefit	Net Farm Cost	Net Value of Production	Benefit	Net Farm Cost	Net Value of Production
1	0.00	0.00	0.00	2.90	0.89	2.01
2	0.00	0.00	0.00	7.48	1.74	5.74
3	0.00	0.00	0.00	12.67	2.63	10.04
4	0.00	0.00	0.00	19.00	3.43	15.57
5	0.00	0.00	0.00	26.67	3.60	23.06
6	0.00	0.00	0.00	41.71	4.32	37.39
7	0.00	0.00	0.00	41.71	4.32	37.39
8	0.00	0.00	0.00	41.71	4.32	37.39
9	0.00	0.00	0.00	41.71	4.32	37.39
10	0.00	0.00	0.00	41.71	4.32	37.39
11	0.00	0.00	0.00	41.71	4.32	37.39
12	0.00	0.00	0.00	41.71	4.32	37.39

11.1.8 Other Agriculture Benefits

352. The other benefits from agriculture and watersheds are those, which directly or indirectly enhance employment opportunities. Expansions in agro-based industry will also a source of employment.

- ***Infrastructure saved:*** The damages caused by the floods will be reduced with the implementation of Siri Toi Storage Dam'. The savings accrued from the flood losses are: a) private property including houses, livestock, land, crops and human lives; and b) government property including public buildings, roads and other public facilities.
- ***Improvement in health condition*: I**mprovement in human diet and nutrition due to increased income and locally available fruits and vegetables. The increased income will also enable them to afford better health facilities.
- ***Improvement in regional environment:*** With the increase in availability of water supply, there will be increase in availability of basic food products to the people and also there would be increase in the income of local and regional people due to the multiplier effect.
- ***Social Benefits:*** Job opportunity has increased during construction of the project. In addition, more on-farm employment opportunities will also be created due to increased availability of good quality irrigation water. Development of industry around the project area is also expected. The increase in income will improve quality of life and standard of living.

11.1.9 Non-Agricultural Benefits

353. ***Health:*** Improved water supply in small pockets is estimated to halve the average cost per household associated with water borne diseases and can prevent loss of 12 days of remuneration of semi-skilled worker. Total benefits are estimated in term of transport, doctor fees, and medicine and laboratory tests. Due to availability of clean drinking water, Hepatitis and other chronic diseases will decrease, thereby improving the health and hygiene and bring a socio economic change.

354. ***Women empowerment:*** Women participation in economic development is quite vital. In rural area the women role is mainly limited to being a house wife, fetching water for drinking, home consumption, washing cloth and arrangement of water and fodder for animals, etc. In all these activities the women usually spend 2-3 hours. To overcome their problem special washing and animal structures have been proposed so that they can save their precious time and utilize it instead on income generating activities like embroidery, house gardening, etc. and can play a role in economic development. Non-agricultural benefits are presented in Table 51 and 52.

Table 52 - Non-agricultural benefits of women empowerment and economic development

S. No.	Women Labour Wage Rates	Unit	Time Saving
1	Daily hours saved (hours)	1.00	1
2	Average hourly wage rate for women (PRs)	37.50	2
3	SWR for female labor	300.00	3
4	Wage Rate for four hours	37.5	4
5	SCF	0.70	5
6	Hour Saved	1.00	6
7	Days	20	7
8	Household women	1,500	8
9	**Financial**	**1.13**	9
10	**Economic**	**0.79**	10

Table 53 - Non-agricultural benefits of women economic activity

No.	Women Economic Activity	No. of Household	Economic Activity		
			Rs. (Month)	Rs. (year)	Million (Rs.)
1	Poultry	15	2280	34200	9,610,200
2	Tailoring	12	4500	54000	15,174,000
3	Embroidery	8	13896	111168	31,238,208
Financial (Million Rs)					**0.20**
Economic (Million Rs.)					**0.18**

355. ***Poverty alleviation:*** Net value of production of crops will increase from nil to 1629 million in “without and with project” scenarios, respectively. This will create additional 3145 full time job opportunities at full development. Hence the scheme development will contribute in the poverty reduction in the scheme area.

11.1.10 Development of Production Models

356. A standard set of crop production models are developed in FARMOD. Prices are applied to these quantities within the financial and economic models. The models reflect local conditions and current practices in each of the scheme. Altitude has a major effect on crop yields and the cropping pattern and calendar. Crop production models are built to identify the

assumptions as to the expected outputs, levels of inputs and crop management practices that will be achieved.

357. ***Outputs:*** Crop production depends on the availability of water and the precision farming practices adopted by the farmers. The farmers in flood schemes are reluctant to change their cropping pattern and risks of crop failure are involved, so the farmers in the scheme grow only those crops whose water requirement is low and varieties are deep rooted. Farmers do not use chemical fertilizers or very little because sediments in the floodwater provides adequate nutritional support. Their farming practices are aimed for risks aversion under low input agriculture. The chemical fertilizers demand that water availability must be increased to achieve the potential. In dry years, fertilizer may have negative impacts on productivity. The arid fruit plants are included and they also do not require chemical fertilizers and only farm yard manures will be used. With reliable water supply the productivity will increase and in wet years farms will start using balanced use of fertilizers but they will hesitate to use any fertilizer in dry years.

358. ***Establishing fruit and forest plants***: Looking at the variability of flows in dry and wet years, forest and fruit plants have been included in the cropping pattern and grasses will be seeded in the fields planted with fruits and forest plants. These deep rooted plants once established will provide source of income during droughts and floods.

359. ***Traded goods***: Economic Prices for traded items as net imports or exports are based on border prices and have been used in the economic analysis which is subject to short term fluctuation.

360. ***Dealing with price inflation***: The analysis has been carried out at constant prices based on current prices of 2013. The use of five years average prices is based on current prices in the month of analysis. Data on current cropping practices, output and farm gate prices were collected through interactive dialogues and semi-structured interviews in the scheme area. Current crop areas are based on interactive dialogues surveys conducted by the Field team using area transect approach.

11.1.11 Financial and Economic Analysis

361. ***Financial analysis:*** The benefits likely to accrue from the implementation of the sub-project are both tangible as well as intangible. The tangible benefits are those which can be directly expressed in monetary terms. These are represented by incremental crop production made possible by the implementation of the proposed project in the three land use patterns. Based on the component wise agronomic data related to present and future cropping intensity, crop yields and associated crop inputs, crop budgets under “with” and “without project” scenarios of economic and financial; prices have been prepared. Total GVP, cost of production, NVP and incremental benefits have been computed by multiplying respective acreage under “without” and “with project” scenarios (Table 54).

362. ***Economic analysis***: The analysis has been carried out in economic prices. The financial prices have been shadow priced to remove distortions on account of taxes and subsidies as well as shortages or surpluses of labour and materials. Shadow pricing has been undertaken by valuing inputs and outputs at border prices expressed in Rupees. As the Rupee is generally free to float in the international currency market, it has not been necessary to shadow price foreign exchange (Table 53). The parameters of economic analysis are:

- ***Price datum***: In the economic analysis, both costs and benefits have been expressed at a constant of price for the year of 2016.
- ***Exchange rate***: In view of the existence of a truly floating exchange rate Rs. 110 to a US$ 1 as prevailing in the year 2016 has been taken to workout export parity prices and would be adopted throughout the analysis.
- ***Standard conversion factor (SCF)***: The standard conversion factor is used to estimate economic accounting prices of goods, which cannot be revalued at border prices because of constraints of information, time, etc. The SCF (0.95) is particularly used in: a) calculation of basic parameters, where national values that are not project specific are needed; b) revaluation of minor non-traded goods for which specific conversion factor are not available unless the specific conversion factors are very similar to standard conversion factor.

Table 54 - Financial analysis of Siri Toi Storage Dam'

Year	Project Cost			Project Benefits					Net Benefits (M.Rs)
	Scheme Development Cost	O&M	Total	Existing Agriculture Benefits	Khushkaba Farming	Watershed	Perennial Command Area	Total	
1	2178	0.0	2178.0	0	0	0	0	0	-2178
2	1634	0.0	1633.5	0	0	0	0	0	-1634
3	1634	0.0	1633.5	0	0	0	0	0	-1634
4		54.5	54.5	0	2	0	133	135	81
5		54.5	54.5	0	6	2	360	367	313
6		54.5	54.5	0	10	6	727	743	689
7		54.5	54.5	0	16	12	1005	1033	979
8		54.5	54.5	0	23	21	1405	1450	1395
9		54.5	54.5	0	37	26	1805	1868	1813
10		54.5	54.5	0	37	26	1805	1868	1813
11		54.5	54.5	0	37	26	1805	1868	1813
12		54.5	54.5	0	37	26	1805	1868	1813
13		54.5	54.5	0	37	26	1805	1868	1813
14		54.5	54.5	0	37	26	1805	1868	1813
15		54.5	54.5	0	37	26	1805	1868	1813
16		54.5	54.5	0	37	26	1805	1868	1813
17		54.5	54.5	0	37	26	1805	1868	1813
18		54.5	54.5	0	37	26	1805	1868	1813
19		54.5	54.5	0	37	26	1805	1868	1813
20		54.5	54.5	0	37	26	1805	1868	1813
21		54.5	54.5	0	37	26	1805	1868	1813
22		54.5	54.5	0	37	26	1805	1868	1813
23		54.5	54.5	0	37	26	1805	1868	1813
24		54.5	54.5	0	37	26	1805	1868	1813
25		54.5	54.5	0	37	26	1805	1868	1813
26		54.5	54.5	0	37	26	1805	1868	1813
27		54.5	54.5	0	37	26	1805	1868	1813
28		54.5	54.5	0	37	26	1805	1868	1813
29		54.5	54.5	0	37	26	1805	1868	1813
30		54.5	54.5	0	37	26	1805	1868	1813
31		54.5	54.5	0	37	26	1805	1868	1813
32		54.5	54.5	0	37	26	1805	1868	1813
33		54.5	54.5	0	37	26	1805	1868	1813
				FIRR				*17.22%*	

Table 55 - Economic Analysis of Sir Toi Storage Dam

Year	Project Cost			Project Benefits					Net Benefits (M.Rs)
	Scheme Development Cost	O&M	Total	Existing Agriculture Benefits	Khushkaba Farming	Watershed	Perennial Command Area	Total	
1	2069	0.0	2069	0	0	0	0	0	-2069
2	1552	0.0	1552	0	0	0	0	0	-1552
3	1552	0.0	1552	0	0	0	0	0	-1552
4		51.7	51.7	0	3	0	116	120	68
5		51.7	51.7	0	5	2	322	328	277
6		51.7	51.7	0	8	5	654	667	615
7		51.7	51.7	0	13	10	905	928	876
8		51.7	51.7	0	21	18	1266	1305	1253
9		51.7	51.7	0	31	21	1629	1681	1629
10		51.7	51.7	0	31	21	1629	1681	1629
11		51.7	51.7	0	31	21	1629	1681	1629
12		51.7	51.7	0	31	21	1629	1681	1629
13		51.7	51.7	0	31	21	1629	1681	1629
14		51.7	51.7	0	31	21	1629	1681	1629
15		51.7	51.7	0	31	21	1629	1681	1629
16		51.7	51.7	0	31	21	1629	1681	1629
17		51.7	51.7	0	31	21	1629	1681	1629
18		51.7	51.7	0	31	21	1629	1681	1629
19		51.7	51.7	0	31	21	1629	1681	1629
20		51.7	51.7	0	31	21	1629	1681	1629
21		51.7	51.7	0	31	21	1629	1681	1629
22		51.7	51.7	0	31	21	1629	1681	1629
23		51.7	51.7	0	31	21	1629	1681	1629
24		51.7	51.7	0	31	21	1629	1681	1629
25		51.7	51.7	0	31	21	1629	1681	1629
26		51.7	51.7	0	31	21	1629	1681	1629
27		51.7	51.7	0	31	21	1629	1681	1629
28		51.7	51.7	0	31	21	1629	1681	1629
29		51.7	51.7	0	31	21	1629	1681	1629
30		51.7	51.7	0	31	21	1629	1681	1629
31		51.7	51.7	0	31	21	1629	1681	1629
32		51.7	51.7	0	31	21	1629	1681	1629
33	0.0	51.7	51.7	0	31	21	1629	1681	1629
				EIRR		***16.58%***			

363. It is advisable to use SCF as sparingly as possible. SCF is an average and therefore specific conversion factor may be used whenever possible. The conversion factors workout in small dam project PC-I study for cement and steel have been used as 0.72 and 0.85, respectively. The SCF is calculated as a ratio of world (border) to domestic prices of imports & exports by estimating the weighted average of the scales of protection on imports and exports. SCF based on 5 years is given in Table 56.

Standard Conversion Factor = (M+X)/{(M+Tm) + (X-Tux)}

Where M = CIF value of imports
X = FOB value of exports
Tm = Net value of taxes on exports

Table 56 - Derivation of Standard Conversion Factor (million Rs.)

Description	2011/12	2012/13	2013/2014	2014/15	20015-16	Average
Total Import	1,851,806	2,512,072	2,723,570	2,910,975	3,455,286	2,690,742
Total Export	1,029,312	1,196,638	1,383,718	1,617,458	2,120,847	1,469,594
Import Duties	138,692.0	156,662.0	146,439.0	156,554.0	179,723.0	155,614
Sales Tax on Imports	111,108	150,724	163,414	174,659	207,317	161,445
Subsidies on Imports	25,488	62,500	57,800	86,300	97,450	65,908
Export Duties	2,573.3	2,991.6	3,459.3	4,043.6	5,302.1	3,674
SCF						**0.95**

Source: Government of Pakistan, Finance Division

364. ***Discount Rate***: The selection of an appropriate discount rate or 'Cash Flow' analysis is a matter of considerable importance. In Pakistan, the marginal productivity of capital is believed to lie somewhere between 9 and 12%. A notification by the Financial Division, Budget Wing Government of Pakistan dated July 2016 regarding rate of mark-up chargeable on development loans and advances by the Federal Government to the Provincial Governments indicates a mark-up rate of 13.17%. The Opportunity Cost of Capital (OCC) in this appraisal has thus been taken as 13.17% for economic appraisal.

365. ***Border prices***: Border prices of wheat, rice, cotton and sugarcane for which Pakistan enters into foreign trade have been updated on the basis of latest available Commodity Forecasts for November, 2013 (World Bank Development Prospects). Border prices of major inputs (i.e. chemical fertilizers) have also been calculated on this basis. Border prices have been converted to rupee prices by using an exchange rate of Rs. 110 to a US Dollar. Necessary adjustments were made to account for transportation and handling charges between the port and market as well as from market to farm-gate.

366. ***Domestic prices***: The estimation of benefits and farm costs is based on farm gate prices of inputs and outputs. For this purpose, the commodities have been categorized as traded and non-traded. The traded commodities are valued at farm gate by applying their FOB/CIF prices (export & import parity prices) and the incidental charges there upon. SCF of 0.95 has been applied to the financial prices of the non-traded commodities to work out their economic values. For non-traded commodities, data from Agriculture, Marketing & Grading Department, and Quetta, Bureau of Statistics, Quetta and Command area of Siri Toi Storage Dam have been collected and processed. The marketing margin and hauling expenses have been deducted from the wholesale market prices to arrive at the farm gate prices are shown as per Annexure.

367. There has been a rising trend in the prices of these commodities in the past and its determination over the future period is difficult to predict with a reasonable degree of certainty. Thus, to avoid too much subjective estimation in the prices, it has been assumed that any increase in the prices of farm products will be balanced by the corresponding increase in the cost of various inputs required for the production of these commodities and the investment made for implementation of the project. Hence constant prices have been used for analysis. Certain corps like wheat and barley by-products of wheat straw & sorghum stalks their values have also been included in the estimation of crop benefits. The main outputs required for the production of crops are fertilizers, seed, insecticides, mechanical and labour and hand tools, because of distortion in prices of these commodities due to government policies and market imperfections, differentiations have been made between the financial and economic prices of these inputs by applying the standard conversion factor. Economic and financial prices are given in Table 57. The import parity prices of wheat and cotton are presented in Table 57.

Table 57 - Economic and financial prices (Rs. /kg)

Crops	Financial Price	Economic Price
Rabi Crops		
Wheat	35.2	27.7
Rabi Vegetable	30.0	28.5
Kharif Crops		
Kharif Vegetable	35.0	33.0
Melon	15.0	14.0
Pulses	85.00	80.0
Fruit Plants		
Mixed Orchards Apricot	45.0	43.0
Bar	9.58	8.62
Forest Plants	15.25	13.73
Falsa	20.03	18.23

Table 58 - Import parity price of wheat and cotton

Parity Price Basis (1)	Wheat	Cotton
	(I)	(E)
Projected Price in Current Dollars $/mt (2)	295.4	2600
Factor	1	1
Quality Adjustment Factor	0.85	0.97
World Market Equivalent $/mt	295.4	2600
Transport and Insurance	52	98.8
cif, Karachi	297.25	2601.97
Exchange Rate Rs/US$	110	110
cif, Karachi (Rs/t)	31508.5	275808.82
Clearance & Port charges	1800	4500
Storage and handeling	1200	3600
Value at Karachi market	34508.5	283908.82
Transport to Project Area (Mill)	1900	3420
Processed Value	36408.5	287328.82
Processing Ratio %	93.6	33
Processing Charges	1820.4	14366.4
Wholesale Value	36408.5	287328.8
Local agent's commission	364.085	2873.2882
Value at farm gate	36772.6	290202.1
Economic Value at farm gate (Rs/40kg)	919.3	2051.5
Local farm gate price (Rs/40kg)	600.0	1500.0
Ratio of border to local farm gate price	1.5	1.4
Financial Price per Kg	35.2	72.0
Economic Price per Kg	27.7	51.0

(1) Parity : [I] Import [E] Export
(2) World Bank Commodity Prices August 2016

368. ***Crops budgets***: A standard set of crop production models are developed in FARMOD. Prices are applied to these quantities within the financial and economic models. The models reflect local conditions and current practices on scheme. Altitude has a major effect on crop yields, cropping pattern and crop calendar. Crop production models are built to identify the assumptions as to the expected outputs, levels of inputs and crop management practices that will be achieved.

369. ***Project benefits***: The implementation of project will result in increased crop production, resulted by increase in cropping intensity from 0 to 120% and improvement in yield/acre. The benefits from farm forest have also been taken on account. Moreover, economic evaluation of the proposed development programme has been carried out by translating these benefits into monetary terms. To be realistic, the project returns must be assessed at their true value to the national economy rather than their mere profitability to the

farmer. The following criteria have been assumed in determining the economic benefits of the Project.

- In the absence of a reliable estimate of variety-wise production of major crops, where price differentials for various varieties are substantial, as for example wheat, a uniform price level has been used.
- In order to visualize realistically the impact of increase in production brought about by the provision on augmented water supplies and to offset inflation, the prices have been kept constant for computing the agricultural benefits.
- In other cases, the Government creates incentives by providing subsidy on farm inputs and reducing the farm prices to well below their true costs; for instance fertilizer, insecticides, pesticides and other farm inputs. Thus, farmers pay less than their real prices. These taxes, duties and subsidies are considered as transfer payments that are not counted for while developing economic costs and benefits.

370. ***Agriculture benefits***: The estimation of crop benefits in the area based on the per acre crop budget for individual crops has been worked out for the four land use patterns under “with ” and “without” project scenarios at economic prices as well as financial prices are produced in the feasibility report. The benefits have been expressed in terms of Net Value of Production (NVP), which is the difference between the Gross Value of Production (GVP) and the estimated Production Costs. Incremental benefits anticipated to flow from project implementation are the difference between the NVP “with” and “without” project situation. On the basis of per acre analysis, NVP “with” and “without” project situation has been worked out, whereas incremental benefits are given in Table 59 to Table 60 for “with project” and Table 10.21 for “without project’ scenarios, respectively.

Table 59 - Project GVP, farm cost and NVP under “with project” scenario for perennial irrigation command area (Economic Prices) of Sir Toi Storage Dam

Crops	Area (hectare)	Economic Prices (million Rs.)			
		GVP (per Ha)	GVP	Farm Cost	NVP
Orchards					
Apricot	805	0.624	501.97	48.78	453
Rabi Crops					
Wheat	966	0.15	147.03	33.42	114
Radish	806	0.47	377.96	308.49	69
Kharif Crops					
Kharif Pulses	806	0.04	30.21	21.91	8
Garlic	644	0.66	424.54	56.30	368
Kharif Vegetable	805	0.52	418.12	63.29	355
Total	**4832**		**1,925**	**296**	**1,629**

Table 60 - Project GVP, farm cost and NVP under "with project" scenario for Khushkaba target area (Economic Prices) of Sir Toi Storage Dam

Crops	Area (hectare)	Economic Prices (million Rs.)			
		GVP (per Acre)	GVP	Farm Cost	NVP
Plants (Fruit, Forest)					
Arid Fruits Plant	25	0.17	4.25	0.20	4.05
Rabi crops					
Barley	72	0.07	4.76	1.63	3.13
Cumin	47	0.19	9.07	0.75	8.32
Kharif Crops					
Sorghum	83	0.05	3.94	0.33	3.61
Sweet Melon	65	0.20	13.25	0.65	12.60
Pulses	69	0.09	6.44	0.76	5.68
Total	**361**		**41.7**	**4.3**	**37.4**

Estimating FIRR and EIRR – Sensitivity Analysis

371. The IRR is estimated by entering the costs streams and benefits streams in columns of a spreadsheet, calculating the net cash flow and using the @ IRR function to calculate the IRR. Two sets of schemes' benefits data are used and calculated at financial and economic prices, these are output by FARMOD. The scheme benefits start in the year following construction so the complete IRR model is over 25 years. It is assumed that the scheme continues at current production in the construction period and these benefits and costs are excluded from the IRR estimate as they balance. The FIRR and EIRR are estimated as % shown in Annexures respectively. The sensitivities of the IRR were tested to reduced and delayed benefits and increased costs and are shown in Table 60. The scheme is not unduly sensitive to departures from the design. ***The sensitivity analysis shows that the EIRR for Sir Toi Storage Dam integrated schemes will vary between dry and wet years from 9.84% to 16.58%. This shows that in potential years EIRR of 16.58% is possible and it can reduce to 11.45% if the benefits are reduced to 40% in terms of productivity from all the land use patterns*** – Perennial Irrigation farming, Khushkaba farming and watershed management. This shows that in both the extremes of wet and dry years the scheme is cost-effective.

372. The design productivity is kept higher than the existing productivity so that in the agriculture component, target is to achieve higher EIRR and net returns. Achieving half of the targeted productivity will keep the scheme cost-effective. The perennial irrigation scheme therefore, EIRR range is important instead of a fixed value for the FIRR and EIRR.

Table 61 - Sensitivity of FIRR and EIRR for Sir Toi Storage Dam' Package

Assumption	Integrated Scheme	
	FIRR	EIRR
Base Model	17.22%	16.58%
Benefits delayed 3 years	13.15%	12.70%
Incremental benefits reduced by 20%	14.80%	14.21%
Construction costs increased by 20%	15.23%	14.63%
Benefits reduced and costs increased by 20%	12.97%	12.43%
Incremental benefits reduced by 40%	11.97%	11.45%
Incremental benefits reduced by 50%	10.33%	9.84%

373. The detailed financial and economic analyses are given in Annexures respectively.

11.1.12 Net Present Value (NPV) and Benefit Cost Ratio (BCR)

374. Economic measures like Net Present Value (NPV), Benefit Cost Ratio (BCR) and Internal Economic Rate of Return (EIRR) have been calculated to examine the economic feasibility of implementation the project. The streams of project benefits and costs have been discounted at 9 percent, 10 percent, and 12 percent of rates of interest and results are summarized in Table 62.

Table 62 - Net present value and benefit-cost ratio at different discount rates for Project

Discount Rate (%)	Cost (million Rs.)	Benefits (million Rs.)	NVP (million Rs.)	B/C
9	4,813.05	10144.15	5331.102	2.1
10	4,695.77	8,864.4	4168.666	1.9
12	4,485.66	6,871.4	2385.715	1.5

BALOCHISTAN WATER RESOURCES DEVELOPMENT PROJECT

SIRI TOI DAM ZHOB RIVER BASIN

COST ESTIMATE

PROJECTSUMMARY

BILL NR	TITLE	AMOUNT
1	MAIN DAM	1,085,060,000
2	DYKE	512,460,000
3	SPILLWAY	1,168,405,000
4	INTAKE STRUCTURE AND OUTLET WORKS	600,609,500
5	MAIN CANAL	889,331,500
6	OFFTAKE STRUCTURE (31 No)	7,473,000
7	FALL STRUCTURE (98 No.)	20,764,000
8	AQUEDUCT (9 No)	272,356,200
9	SIPHON (3 No)	87,847,000
10	DRAINAGE CULVERT (5 No)	2,812,000
11	ROAD CULVERT (2 No)	23,007,500
12	WASHING STRUCTURE (5 No)	1,392,760
13	CATTLE DRINKING TROUGH (5 No)	225,900
14	DRINKING WATER SUPPLY SYSTEM	8,750,000
15	PARAPET WALL	62,411,655
	TOTAL 1 TO 13	4,742,906,015
	GRAND TOTAL	4,742,906,015

BALOCHISTAN WATER RESOURCES DEVELOPMENT PROJECT

SIRI TOI DAM ZHOB RIVER BASIN

COST ESTIMATE

BILL NO - 1 :- MAIN DAM

ITEM. No.	DESCRIPTION	UNIT	QUANTITY	RATE (Rs)	AMOUNT (Rs)
1	Bulk Excavation in Overburden.	Cu.m	8,000	870	6,960,000
2	Bulk Excavation in Rock.	Cu.m	1,000	1,900	1,900,000
3	Structural Excavation in Rock.	Cu.m	1,000	1,900	1,900,000
4	Incidental Excavation .	Cu.m	500	970	485,000
5	Dental Concrete	Cu.m	1,310	14,500	18,995,000
6	Slush Grout.	Cu.m	2,600	5,700	14,820,000
7	Impervious core fill material (Zone - 1)	Cu.m	312,500	660	206,250,000
8	Sandy gravel fill (Zone - 2)	Cu.m	375,000	500	187,500,000
9	Random fill (Zone - 3)	Cu.m	375,000	710	266,250,000
10	Fine filter material for chimney drain (Zone - 6)	Cu.m	31,250	1,200	37,500,000
11	Fine filter material in horizontal blanket (Zone - 6)	Cu.m	31,250	1,200	37,500,000
12	Drain material (Zone - 7)	Cu.m	37,500	1,200	45,000,000
13	Washed gravel (Zone - 4a)	Cu.m	37,500	800	30,000,000
14	Down stream slope protection (Zone - 4b)	Cu.m	25,000	1,200	30,000,000
15	Rip Rap R-1 (Zone - 5)	Cu.m	25,000	3,000	75,000,000
16	Rip Rap R-2 (Zone - 5)	Cu.m	25,000	3,000	75,000,000
17	Sheet piling	Sq.m	1,000	50,000	50,000,000
	CARRIED TO COLLECTION				**1,085,060,000**

BALOCHISTAN WATER RESOURCES DEVELOPMENT PROJECT

SIRI TOI DAM ZHOB RIVER BASIN

COST ESTIMATE

BILL NO - 1 :- MAIN DAM

S.No.	PAGE NO	AMOUNT
1	B.O.Q PAGE NO - 2	1,085,060,000
CARRIED TO SUMMARY		1,085,060,000

BALOCHISTAN WATER RESOURCES DEVELOPMENT PROJECT

SIRI TOI DAM ZHOB RIVER BASIN

COST ESTIMATE

BILL NO - 2 :- DYKE

ITEM. No.	DESCRIPTION	UNIT	QUANTITY	RATE (Rs)	AMOUNT (Rs)
	EARTHEN DYKES (1 Nos)				
1	Bulk Excavation in Overburden.	Cu.m	3,000	870	2,610,000
2	Bulk Excavation in Rock.	Cu.m	1,000	900	900,000
3	Structural Excavation in Rock.	Cu.m	500	900	450,000
4	Impervious core fill material (Zone - 1)	Cu.m	187,500	660	123,750,000
5	Sandy gravel fill (Zone - 2)	Cu.m	225,000	500	112,500,000
6	Random fill (Zone - 3)	Cu.m	225,000	710	159,750,000
7	Fine filter fill material for chimney drain (Zone - 6)	Cu.m	18,750	1,000	18,750,000
8	Fine filter material in drainage blanket (Zone - 6)	Cu.m	18,750	1,000	18,750,000
9	Drain material (Zone - 7)	Cu.m	22,500	1,000	22,500,000
10	Washed gravel (Zone - 4a)	Cu.m	22,500	800	18,000,000
11	Down stream slope protection (Zone - 4b)	Cu.m	15,000	800	12,000,000
12	Rip Rap R-2 (Zone - 5)	Cu.m	15,000	1,500	22,500,000
CARRIED TO COLLECTION					**512,460,000**

BALOCHISTAN WATER RESOURCES DEVELOPMENT PROJECT

SIRI TOI DAM ZHOB RIVER BASIN

COST ESTIMATE

BILL NO - 2 :- DYKE

S.No.	PAGE NO	AMOUNT
1	B.O.Q PAGE NO - 4	512,460,000
CARRIED TO SUMMARY		512,460,000

BALOCHISTAN WATER RESOURCES DEVELOPMENT PROJECT

SIRI TOI DAM ZHOB RIVER BASIN

COST ESTIMATE

BILL NO - 3 :- SPILLWAY

ITEM. No.	DESCRIPTION	UNIT	QUANTITY	RATE (Rs)	AMOUNT (Rs)
	EARTH WORKS				
1	Bulk Excavation in Overburden.	Cu.m	12,800	870	11,136,000
2	Bulk Excavation in Rock. (Lead 3 Km)	Cu.m	128,000	900	115,200,000
3	Structural Excavation in Overburden.	Cu.m	115,200	770	88,704,000
4	Structural Excavation in Rock.	Cu.m	384,000	900	345,600,000
5	Incidental Excavation .	Cu.m	500	770	385,000
6	Trench Excavation in Rock	Cu.m	500	1,500	750,000
7	Compacted gravel fill R.C floor bed, R.C lining and Bank along tailrace channel.	Cu.m	13,000	800	10,400,000
8	Backfilling around the retaining walls and others structures.	Cu.m	10,000	550	5,500,000
9	Stone pitching	Cu.m	2,000	3,000	6,000,000
10	Base filter under Stone pitching	Cu.m	2,000	800	1,600,000
11	Stone Apron	Cu.m	5,000	3,000	15,000,000
12	Base filter under Stone Apron	Cu.m	2,500	800	2,000,000
12	Blasting for Rock	Cu.m	8,000	1,500	12,000,000
	CONCRETE WORKS				
	WEIR AND UPSTREAM FLOOR				
14	Lean concrete class 10/20 under floor	Cu.m	3,000	8,000	24,000,000
15	Concrete class C 30/20 in U/S floor	Cu.m	3,100	12,000	37,200,000
16	Concrete class C 30/20 in weir floor	Cu.m	4,100	12,000	49,200,000
17	Reinforcement (Grade - 60)	M. Ton	720	143,000	102,960,000
	CARRIED TO COLLECTION				**827,635,000**

BALOCHISTAN WATER RESOURCES DEVELOPMENT PROJECT

SIRI TOI DAM ZHOB RIVER BASIN

COST ESTIMATE

BILL NO - 3 :- SPILLWAY

ITEM. No.	DESCRIPTION	UNIT	QUANTITY	RATE (Rs)	AMOUNT (Rs)
	STILLING BASIN				
18	Lean concrete class 10/20 under floor	Cu.m	540	8,000	4,320,000
19	Concrete class C 30/20 in floor	Cu.m	7,500	12,000	90,000,000
20	Concrete class C 30/20 in chute blocks	Cu.m	500	12,500	6,250,000
21	Reinforcement (Grade - 60)	M. Ton	800	143,000	114,400,000
22	Sealant in expansion joints.	L.m	500	820	410,000
23	Water stop in expansion / contraction / construction joint (Type A)	L.m	500	3,300	1,650,000
24	Contraction joint / control joints bond breaking coating	Sq.m	500	1,100	550,000
25	Rock ground anchors (2 m long in ground) including drilling and grouting.	M. Ton	50	300,000	15,000,000
	APPROACH WALLS, ABUTMENTS AND CHUTE WALLS (SPILLWAY)				
26	Lean concrete class 10/20 under all walls.	Cu.m	200	8,000	1,600,000
27	Facing Concrete class C 30/20 in walls.	Cu.m	2,000	12,000	24,000,000
28	Mass Concrete class C 14/20 in walls.	Cu.m	500	9,000	4,500,000
29	Reinforcement (Grade - 60)	M. Ton	280	143,000	40,040,000
30	Sealant in expansion joints.	L.m	1,000	850	850,000
31	Water stop in expansion / contraction / construction joint (Type A)	L.m	1,000	3,300	3,300,000
	CARRIED TO COLLECTION				**306,870,000**

BALOCHISTAN WATER RESOURCES DEVELOPMENT PROJECT

SIRI TOI DAM ZHOB RIVER BASIN

COST ESTIMATE

BILL NO - 3 :- SPILLWAY

ITEM. No.	DESCRIPTION	UNIT	QUANTITY	RATE (Rs)	AMOUNT (Rs)
33	Application for bond breaking compound at contraction joint.	Sq.m	3,000	1,100	3,300,000
34	Performed filler in expansion joints	Sq.m	1,000	1,100	1,100,000
	TAILRACE CHANNEL				
35	Provide and lay stone pitching dry hand packed in apron.	Cu.m	8,000	3,500	28,000,000
36	Provide and lay filter under the stone apron.	Cu.m	1,500	1,000	1,500,000
CARRIED TO SUMMARY					**33,900,000**

BALOCHISTAN WATER RESOURCES DEVELOPMENT PROJECT

SIRI TOI DAM ZHOB RIVER BASIN

COST ESTIMATE

BILL NO - 3 :- SPILLWAY

S.No.	PAGE NO	AMOUNT
1	B.O.Q PAGE NO - 6	827,635,000
2	B.O.Q PAGE NO - 7	306,870,000
3	B.O.Q PAGE NO - 8	33,900,000
	CARRIED TO SUMMARY	1,168,405,000

BALOCHISTAN WATER RESOURCES DEVELOPMENT PROJECT

SIRI TOI DAM ZHOB RIVER BASIN

COST ESTIMATE

BILL NO - 4 :- INTAKE STRUCTURE AND OUTLET WORKS

ITEM. No.	DESCRIPTION	UNIT	QUANTITY	RATE (Rs)	AMOUNT (Rs)
1	Bulk Excavation in Overburden.	Cu.m	8,000	770	6,160,000
2	Structural Excavation in Rock.	Cu.m	2,000	900	1,800,000
3	Trench Excavation in Rock.	Cu.m	5,000	1,500	7,500,000
4	Compacted backfill	Cu.m	2,000	550	1,100,000
5	Lean concrete class 10/20 under floor	Cu.m	115	8,000	920,000
6	Concrete class C 30/20 in RC Floor	Cu.m	50	12,000	600,000
7	Concrete class C 30/20 in Conduit	Cu.m	3,050	12,500	38,125,000
8	Concrete class C 30/20 in Hoisting Arrangement	Cu.m	145	13,000	1,885,000
9	Reinforcement (Grade - 60)	M. Ton	409	143,000	58,487,000
10	Steel rungs (Grade - 60)	M. Ton	30	150,000	4,500,000
11	Bond breaking coating in contraction joints	Sq.m	30	1,100	33,000
12	Water stop in contraction joints (Type-A)	L.m	50	3,300	165,000
13	<u>FIXED WHEEL GATE EQUIPMENT</u> <u>GATE No-1,2 AND 3 Size 2.5 m X 2.5 m</u>				
i	Gate leaf assembly	Set	3	3,000,000	9,000,000
ii	Electrically / manually operated wire rope and drum type hoisting system	Set	3	2,500,000	7,500,000
iii	Embedded metal parts.	Set	3	1,500,000	4,500,000
	CARRIED TO COLLECTION				**142,275,000**

BALOCHISTAN WATER RESOURCES DEVELOPMENT PROJECT

SIRI TOI DAM ZHOB RIVER BASIN

COST ESTIMATE

BILL NO - 4 :- INTAKE STRUCTURE AND OUTLET WORKS

ITEM. No.	DESCRIPTION	UNIT	QUANTITY	RATE (Rs)	AMOUNT (Rs)
	EMERGENCY GATE - Size 1.5 m X 2.6 m				
i	Gate leaf assembly	Set	1	1,872,000	1,872,000
ii	Electrically / manually operated wire rope and drum type hoisting system	Set	1	1,560,000	1,560,000
iii	Embedded metal parts.	Set	1	936,000	936,000
14	SEMICIRCULAR TRASH RACK (Size 3 m X 3 m)				
i	Trash rack steel structure	Set	1	1,500,000	1,500,000
ii	Embedded metal parts.	Set	1	1,100,000	1,100,000
iii	Electrically / manually operated wire rope and drum type hoisting system	Set	1	1,350,000	1,350,000
15	Hoisting platform and hand railing for operating system of all the three intake gates and trash rack.	Set	1	2,500,000	2,500,000
16	MS pipe made of ASTM A 537, Class I as specified				
i)	Dia 1000mm X 10 mm thick	Rm	1,650	222,000	366,300,000
17	Concrete class D (28 MPA) in Pipe Support	Cu.m	150	14,500	2,175,000
18	Steel rungs (Grade - 60) for pipe support	M. Ton	405	150,000	60,750,000
19	Control Room	Sq.m	192	32,500	6,240,000
20	Butterfly Valve 1000 mm dia	No	1	3,200,000	3,200,000
21	Hollow jet Valve 800 mm dia	No	1	4,000,000	4,000,000
22	MS Flanged Short piece 1000 mm dia	No	2	200,000	400,000
	CARRIED TO COLLECTION				**453,883,000**

BALOCHISTAN WATER RESOURCES DEVELOPMENT PROJECT

SIRI TOI DAM ZHOB RIVER BASIN

COST ESTIMATE

BILL NO - 4 :- INTAKE STRUCTURE AND OUTLET WORKS

ITEM. No.	DESCRIPTION	UNIT	QUANTITY	RATE (Rs)	AMOUNT (Rs)
23	MS Reducer 1000 X 800 mm dia	No	1	150,000	150,000
24	MS Bend 800 mm dia	No	1	275,000	275,000
	ENERGY DISSIPATOR				
25	Lean concrete class 10/20 under floor	Cu.m	10	8,000	80,000
26	Concrete class C 30/20 in floor	Cu.m	60	12,000	720,000
27	Concrete classC 30/20 in Wall	Cu.m	58	13,000	754,000
28	Concrete class C 30/20 in chute blocks	Cu.m	25	12,500	312,500
29	Reinforcement (Grade - 60)	M. Ton	18	120,000	2,160,000
	CARRIED TO SUMMARY				**4,451,500**

BALOCHISTAN WATER RESOURCES DEVELOPMENT PROJECT

SIRI TOI DAM ZHOB RIVER BASIN

COST ESTIMATE

BILL NO - 4 :- INTAKE STRUCTURE AND OUTLET WORKS

S.No.	PAGE NO	AMOUNT
1	B.O.Q PAGE NO - 10	142,275,000
2	B.O.Q PAGE NO - 11	453,883,000
3	B.O.Q PAGE NO - 12	4,451,500
	CARRIED TO SUMMARY	600,609,500

BALOCHISTAN WATER RESOURCES DEVELOPMENT PROJECT

SIRI TOI DAM ZHOB RIVER BASIN

COST ESTIMATE

BILL NO - 5:- MAIN CANAL AND IRRIGATION SYSTEM

ITEM.No.	DESCRIPTION	UNIT	QUANTITY	RATE (Rs)	AMOUNT (Rs)
1	BULK EXCAVATION IN OVERBURDEN	Cu.m	10,000	770	7,700,000
2	Structural excavation in overburden including preparation and dressing of sub grade for concrete lining along the canal and distributries bed and side slopes.	Cu.m	130,000	770	100,100,000
3	Compacted earth fill including preparation and dressing of sub grade, bed and side slopes of main canal and distributaries .	Cu.m	472,800	550	260,040,000
	MAIN CANAL				
4	Lean concrete class 10/20 under bed and slope	Cu.m	13,054	8,000	104,432,000
5	Concrete class C 30 in Lining				
	a) In Bed	Cu.m	3,740	10,500	39,270,000
	b) On Slopes.	Cu.m	15,488	11,500	178,112,000
6	Providing and installation of PVC Geomembrance, 0.5 mm thick, (PG1-1104 specs) under concrete lining.				
	a) In Bed	Sq.m	37,400	260	9,724,000
	b) On Slopes.	Sq.m	154,880	275	42,592,000
	DISTRIBUTARY CANAL				
7	Concrete class C 30 in Lining				
	a) In Bed	Cu.m	1,760	10,500	18,480,000
	b) On Slopes.	Cu.m	5,120	11,500	58,880,000
CARRIED TO COLLECTION					**819,330,000**

BALOCHISTAN WATER RESOURCES DEVELOPMENT PROJECT

SIRI TOI DAM ZHOB RIVER BASIN

COST ESTIMATE

BILL NO - 5:- MAIN CANAL AND IRRIGATION SYSTEM

ITEM.No.	DESCRIPTION	UNIT	QUANTITY	RATE (Rs)	AMOUNT (Rs)
8	Providing and installation of PVC Geomembrance, 0.5 mm thick, (PG1-1104 specs) under concrete lining.				
	a) In Bed	Sq.m	17,600	260	4,576,000
	b) On Slopes.	Sq.m	51,200	275	14,080,000
9	Providing and applying 2 coats of hot bitumen @ 1 kg per sq.m, each coat, to the concrete surfaces in contact with the earth and contraction joints, complete as directed by the Engineer.	sq.m	7,832	500	3,916,000
10	Preparation of concrete surfaces and installation and fixing of compressible, self expanding cork filler for expansion joints	sq.m	870	4,500	3,915,000
11	Supplying and applying Safe elastic V or similar approved joint sealant in contraction and expansion joints	Rm	87,029	500	43,514,500
	CARRIED TO SUMMARY				**70,001,500**

BALOCHISTAN WATER RESOURCES DEVELOPMENT PROJECT

SIRI TOI DAM ZHOB RIVER BASIN

COST ESTIMATE

BILL NO - 5:- MAIN CANAL AND IRRIGATION SYSTEM

S.No.	PAGE NO	AMOUNT
1	B.O.Q PAGE NO - 14	819,330,000
2	B.O.Q PAGE NO - 15	70,001,500
CARRIED TO SUMMARY		889,331,500

BALOCHISTAN WATER RESOURCES DEVELOPMENT PROJECT

SIRI TOI DAM ZHOB RIVER BASIN

COST ESTIMATE

BILL NO - 6 : OFFTAKE STRUCTURE (31 No.)

S.No.	ITEMS OF WORKS	UNIT	QUANTITY	RATE	AMOUNT
1	Excavation for Irrigation channel / Structures in all kinds of soils upto required depth (except hard rock) including all operations of site clearing, grubbing, dewatering of sub soil water, surface water, and other sources. Levelling, dressing and compacted the excavated surface including backfilling and disposal of excavated surplus material to designated disposal areas within 1 Km, all complete as per drawings, specifications and as directed by the Engineer.	cu.m	1,395	500	697,500
2	Providing and laying plain cement concrete Class 10/20 using ordinary Portland cement, in situ concrete including formwork, mixing, pouring, levelling, compacting, vibrating and curing complete as per drawings, specifications and as directed by the Engineer.	cu.m	47	8,000	376,000
3	Providing and laying in situ R.C.C Class C-30/20 using ordinary Portland cement in Circular / Rectangular manhole and elsewhere including formwork, mixing, pouring, levelling, compacting, vibrating and curing, complete as per drawings, specification and as directed by the Engineer (Excluding Steel reinforcement)				
	i) In Base Slab	cu.m	96	9,000	864,000
	ii) In Walls	cu.m	105	10,000	1,050,000
	CARRIED TO COLLECTION				2,987,500

BALOCHISTAN WATER RESOURCES DEVELOPMENT PROJECT

SIRI TOI DAM ZHOB RIVER BASIN

COST ESTIMATE

BILL NO - 6 : OFFTAKE STRUCTURE (31 No.)

S.No.	ITEMS OF WORKS	UNIT	QUANTITY	RATE	AMOUNT
4	Providing, Placing and fixing in position Deformed steel reinforcement bars, confirming to BS 4449 or ASTM A-615 with minimum Yield strength of 420 N/mm^2 including cutting, bending, binding, straightening, wastage, overlaps, chairs and tying with binding wire complete, at any height and any floor as per design, drawings, specifications and as directed by the Engineer.	tonne	23	143,000	3,289,000
5	Providing and applying 2 coats of hot bitumen @ 1 kg per sq.m, each coat, to the concrete surfaces in contact with the earth and contraction joints, complete as directed by the Engineer.	sq.m	843	500	421,500
6	Supplying and applying Safe elastic V or similar approved joint sealant in contraction and expansion joints	Rm	155	500	77,500
7	Supplying and applying PVC water Stopper in contraction and expansion joints	Rm	155	1,800	279,000
8	Providing and fixing galvanized iron shutters various Sizes including chain as shown in the drawing complete in all respect with all necessary accessories according to required shape and size.				
	i) For Main Canal	No.	31	5,000	155,000
	i) For Distributary Canal	No.	31	3,500	108,500
9	Providing and fixing galvanized iron frames to suit shutters of size as shown in the drawing complete in all respect with all necessary accessories according to required size.				
	i) For Main Canal	No.	31	3,000	93,000
	i) For Distributary Canal	No.	31	2,000	62,000
	CARRIED TO COLLECTION				4,485,500

BALOCHISTAN WATER RESOURCES DEVELOPMENT PROJECT

SIRI TOI DAM ZHOB RIVER BASIN

COST ESTIMATE

BILL NO - 6 : OFFTAKE STRUCTURE (31 No.)

S.No.	PAGE NO	AMOUNT
1	B.O.Q PAGE NO - 17	2,987,500
2	B.O.Q PAGE NO - 18	4,485,500
	CARRIED TO SUMMARY	7,473,000

BALOCHISTAN WATER RESOURCES DEVELOPMENT PROJECT

SIRI TOI DAM ZHOB RIVER BASIN

COST ESTIMATE

BILL NO -7 : FALL STRUCTURE (98 No.)

S.No.	ITEMS OF WORKS	UNIT	QUANTITY	RATE	AMOUNT
1	Excavation for Irrigation channel / Structures in all kinds of soils upto required depth (except hard rock) including all operations of site clearing, grubbing, dewatering of sub soil water, surface water, and other sources. Levelling, dressing and compacted the excavated surface including backfilling and disposal of excavated surplus material to designated disposal areas within 1 Km, all complete as per drawings, specifications and as directed by the Engineer.	cu.m	4,100	500	2,050,000
2	Providing and laying plain cement concrete Class 10/20 using ordinary Portland cement, in situ concrete including formwork, mixing, pouring, levelling, compacting, vibrating and curing complete as per drawings, specifications and as directed by the Engineer.	cu.m	60	8,000	480,000
3	Providing and laying plain cement concrete Class 30/20 using ordinary Portland cement, in situ concrete including formwork, mixing, pouring, levelling, compacting, vibrating and curing complete as per drawings, specifications and as directed by the Engineer.	cu.m	5	8,000	40,000
4	Providing and laying in situ R.C.C Class C-30/20 using ordinary Portland cement in Fall Structure and elsewhere including formwork, mixing, pouring, levelling, compacting, vibrating and curing, complete as per drawings, specification and as directed by the Engineer (Excluding Steel reinforcement)				
	i) In Base Slab	cu.m	310	9,000	2,790,000
	ii) In Walls	cu.m	255	10,000	2,550,000
	iii) In Chute / Baffle Block	cu.m	170	10,000	1,700,000
	CARRIED TO COLLECTION				9,610,000

BALOCHISTAN WATER RESOURCES DEVELOPMENT PROJECT

SIRI TOI DAM ZHOB RIVER BASIN

COST ESTIMATE

BILL NO -7 : FALL STRUCTURE (98 No.)

S.No.	ITEMS OF WORKS	UNIT	QUANTITY	RATE	AMOUNT
5	Providing, Placing and fixing in position Deformed steel reinforcement bars, confirming to BS 4449 or ASTM A-615 with minimum Yield strength of 420 N/mm^2 including cutting, bending, binding, straightening, wastage, overlaps, chairs and tying with binding wire complete, at any height and any floor as per design, drawings, specifications and as directed by the Engineer.	tonne	63	143,000	9,009,000
6	Providing and applying 2 coats of hot bitumen @ 1 kg per sq.m, each coat, to the concrete surfaces in contact with the earth and contraction joints, complete as directed by the Engineer.	sq.m	2,275	500	1,137,500
7	Preparation of concrete surfaces and installation and fixing of compressible, self expanding cork filler for expansion joints	sq.m	110	4,500	495,000
8	Supplying and applying Safe elastic V or similar approved joint sealant in contraction and expansion joints	Rm	1,025	500	512,500
	CARRIED TO COLLECTION				11,154,000

BALOCHISTAN WATER RESOURCES DEVELOPMENT PROJECT

SIRI TOI DAM ZHOB RIVER BASIN

COST ESTIMATE

BILL NO -7 : FALL STRUCTURE (98 No.)

S.No.	PAGE NO	AMOUNT
1	B.O.Q PAGE NO - 20	9,610,000
2	B.O.Q PAGE NO - 21	11,154,000
	CARRIED TO SUMMARY	20,764,000

BALOCHISTAN WATER RESOURCES DEVELOPMENT PROJECT

SIRI TOI DAM ZHOB RIVER BASIN

COST ESTIMATE

BILL NO - 8 : AQUEDUCT (9 No.)

S.No.	ITEMS OF WORKS	UNIT	QUANTITY	RATE	AMOUNT
1	Excavation for Irrigation channel / Structures in all kinds of soils upto required depth (except hard rock) including all operations of site clearing, grubbing, dewatering of sub soil water, surface water, and other sources. Levelling, dressing and compacted the excavated surface including backfilling and disposal of excavated surplus material to designated disposal areas within 1 Km, all complete as per drawings, specifications and as directed by the Engineer.	cu.m	8,500	500	4,250,000
2	Providing and laying plain cement concrete Class 10/20 using ordinary Portland cement, in situ concrete including formwork, mixing, pouring, levelling, compacting, vibrating and curing complete as per drawings, specifications and as directed by the Engineer.	cu.m	200	8,000	1,600,000
3	Providing and laying in situ R.C.C Class C-30/20 using ordinary Portland cement in Aqueduct and elsewhere including formwork, mixing, pouring, levelling, compacting, vibrating and curing, complete as per drawings, specification and as directed by the Engineer (Excluding Steel reinforcement)				
	i) In Footing	cu.m	755	9,000	6,795,000
	ii) In Pier	cu.m	7,995	10,000	79,950,000
	CARRIED TO COLLECTION				92,595,000

BALOCHISTAN WATER RESOURCES DEVELOPMENT PROJECT

SIRI TOI DAM ZHOB RIVER BASIN

COST ESTIMATE

BILL NO - 8 : AQUEDUCT (9 No.)

S.No.	ITEMS OF WORKS	UNIT	QUANTITY	RATE	AMOUNT
	iii) In Channel Base Slab	cu.m	880	9,000	7,920,000
	ii) In Walls	cu.m	1,060	10,000	10,600,000
4	Providing, Placing and fixing in position Deformed steel reinforcement bars, confirming to BS 4449 or ASTM A-615 with minimum Yield strength of 420 N/mm^2 including cutting, bending, binding, straightening, wastage, overlaps, chairs and tying with binding wire complete, at any height and any floor as per design, drawings, specifications and as directed by the Engineer.	tonne	1,197	143,000	171,171,000
5	Rubble stone masonry in 1:3 CS Mortar with flush pointed joints in walls	cu.m	800	6,500	5,200,000
6	Providing and applying 2 coats of hot bitumen @ 1 kg per sq.m, each coat, to the concrete surfaces in contact with the earth and contraction joints, complete as directed by the Engineer.	sq.m	5,750	500	2,875,000
7	Supplying and applying Safe elastic V or similar approved joint sealant in contraction and expansion joints	Rm	224	500	112,000
8	Supplying and applying PVC water Stopper in contraction and expansion joints	Rm	224	1,800	403,200
	CARRIED TO COLLECTION				179,761,200

BALOCHISTAN WATER RESOURCES DEVELOPMENT PROJECT

SIRI TOI DAM ZHOB RIVER BASIN

COST ESTIMATE

BILL NO - 8 : AQUEDUCT (9 No.)

S.No.	PAGE NO	AMOUNT
1	B.O.Q PAGE NO - 23	92,595,000
2	B.O.Q PAGE NO - 24	179,761,200
	CARRIED TO SUMMARY	272,356,200

BALOCHISTAN WATER RESOURCES DEVELOPMENT PROJECT

SIRI TOI DAM ZHOB RIVER BASIN

COST ESTIMATE

BILL NO - 9 : SIPHON (3 No.)

S.No.	ITEMS OF WORKS	UNIT	QUANTITY	RATE	AMOUNT
1	Excavation for Irrigation channel / Structures in all kinds of soils upto required depth (except hard rock) including all operations of site clearing, grubbing, dewatering of sub soil water, surface water, and other sources. Levelling, dressing and compacted the excavated surface including backfilling and disposal of excavated surplus material to designated disposal areas within 1 Km, all complete as per drawings, specifications and as directed by the Engineer.	cu.m	4,100	500	2,050,000
2	Providing and laying plain cement concrete Class 10/20 using ordinary Portland cement, in situ concrete including formwork, mixing, pouring, levelling, compacting, vibrating and curing complete as per drawings, specifications and as directed by the Engineer.	cu.m	190	8,000	1,520,000
3	Providing and laying in situ R.C.C Class C-30/20 using ordinary Portland cement in Siphon and elsewhere including formwork, mixing, pouring, levelling, compacting, vibrating and curing, complete as per drawings, specification and as directed by the Engineer (Excluding Steel reinforcement)				
	i) In Base Slab	cu.m	685	9,000	6,165,000
	ii) In Walls	cu.m	35	10,000	350,000
	CARRIED TO COLLECTION				10,085,000

BALOCHISTAN WATER RESOURCES DEVELOPMENT PROJECT

SIRI TOI DAM ZHOB RIVER BASIN

COST ESTIMATE

BILL NO - 9 : SIPHON (3 No.)

S.No.	ITEMS OF WORKS	UNIT	QUANTITY	RATE	AMOUNT
4	Providing, Placing and fixing in position Deformed steel reinforcement bars, confirming to BS 4449 or ASTM A-615 with minimum Yield strength of 420 N/mm^2 including cutting, bending, binding, straightening, wastage, overlaps, chairs and tying with binding wire complete, at any height and any floor as per design, drawings, specifications and as directed by the Engineer.	tonne	81	143,000	11,583,000
5	Providing and applying 2 coats of hot bitumen @ 1 kg per sq.m, each coat, to the concrete surfaces in contact with the earth and contraction joints, complete as directed by the Engineer.	sq.m	715	500	357,500
6	Supplying and applying Safe elastic V or similar approved joint sealant in contraction and expansion joints	Rm	20	500	10,000
7	Preparation of concrete surfaces and installation and fixing of compressible, self expanding cork filler for expansion joints	sq.m	3	4,500	13,500
8	Providing and fixing galvanized iron shutters various Sizes including chain as shown in the drawing complete in all respect with all necessary accessories according to required shape and size.	No.	3	5,000	15,000
	CARRIED TO COLLECTION				11,979,000

BALOCHISTAN WATER RESOURCES DEVELOPMENT PROJECT

SIRI TOI DAM ZHOB RIVER BASIN

COST ESTIMATE

BILL NO - 9 : SIPHON (3 No.)

S.No.	ITEMS OF WORKS	UNIT	QUANTITY	RATE	AMOUNT
9	Providing and fixing galvanized iron frames to suit shutters of size as shown in the drawing complete in all respect with all necessary accessories according to required size.	No.	3	5,000	15,000
10	Providing laying and jointing of 800mm dia Polye thylene pressure pipes (HDPE - 100) PN 10 Confirming TO ISO - 4427, DIN 8074, 8075 or PS 3580 : 1994, manufactured by API certified firms in trenches excluding cost of fittings and specials, Complete as per specifications, drawings and as directed by the Engineer.	Rm	1,000	65,000	65,000,000
11	Providing laying and jointing of 800mm dia Polye thylene pressure pipes Bend (HDPE - 100) PN 10 Confirming TO ISO - 4427, DIN 8074, 8075 or PS 3580 : 1994, manufactured by API certified firms in trenches excluding cost of fittings and specials, Complete as per specifications, drawings and as directed by the Engineer.	No.	12	60,000	720,000
12	Providing and fixing 20mm Dia Galvanized iron Foot steps at every 300 mm centre to centre complete as per drawings, specifications & as directed by the Engineer.	No.	60	800	48,000
	CARRIED TO COLLECTION				65,783,000

BALOCHISTAN WATER RESOURCES DEVELOPMENT PROJECT

SIRI TOI DAM ZHOB RIVER BASIN

COST ESTIMATE

BILL NO - 9 : SIPHON (3 No.)

S.No.	PAGE NO	AMOUNT
1	B.O.Q PAGE NO - 26	10,085,000
2	B.O.Q PAGE NO - 27	11,979,000
3	B.O.Q PAGE NO - 28	65,783,000
	CARRIED TO SUMMARY	87,847,000

BALOCHISTAN WATER RESOURCES DEVELOPMENT PROJECT

SIRI TOI DAM ZHOB RIVER BASIN

COST ESTIMATE

BILL NO - 10 : DRAINAGE CULVERT (5 No.)

S.No.	ITEMS OF WORKS	UNIT	QUANTITY	RATE	AMOUNT
1	Excavation in natural ground under dry conditions including backfilling arround structure and disposal of excavated material up to a distance of 1 Km.	cu.m	392	500	196,000
2	Providing and laying in situ Plain cement concrete Class C-10/20 using ordinary Portland cement in Structure manhole and elsewhere including formwork, mixing, pouring, levelling, compacting, vibrating and curing, complete as per drawings, specification and as directed by the Engineer.	cu.m	13	8,500	110,500
3	Providing and laying in situ Plain cement concrete Class C-30/20 using ordinary Portland cement in Structure manhole and elsewhere including formwork, mixing, pouring, levelling, compacting, vibrating and curing, complete as per drawings, specification and as directed by the Engineer.				
	i) In Base Slab	cu.m	25	9,000	225,000
	ii) In Walls and Wing walls	cu.m	35	10,000	350,000
	iii) In Top Slab	cu.m	32	10,500	336,000
4	Providing, Placing and fixing in position Deformed steel reinforcement bars, confirming to BS 4449 or ASTM A-615 with minimum Yield strength of 420 N/mm^2 including cutting, bending, binding, straightening, wastage, overlaps, chairs and tying with binding wire complete, at any height and any floor as per design, drawings, specifications and as directed by the Engineer.	tonne	10	143,000	1,430,000
5	Providing and applying 2 coats of hot bitumen @ 1 kg per sq.m, each coat, to the concrete surfaces in contact with the earth and contraction joints, complete as directed by the Engineer.	sq.m	329	500	164,500
	CARRIED TO COLLECTION				2,812,000

BALOCHISTAN WATER RESOURCES DEVELOPMENT PROJECT

SIRI TOI DAM ZHOB RIVER BASIN

COST ESTIMATE

BILL NO - 10 : DRAINAGE CULVERT (5 No.)

S.No.	PAGE NO	AMOUNT
1	B.O.Q PAGE NO - 30	2,812,000
	CARRIED TO SUMMARY	2,812,000

BALOCHISTAN WATER RESOURCES DEVELOPMENT PROJECT

SIRI TOI DAM ZHOB RIVER BASIN

COST ESTIMATE

BILL NO - 11 : ROAD CULVERT (2 No.)

S.No.	ITEMS OF WORKS	UNIT	QUANTITY	RATE	AMOUNT
1	Excavation in natural ground under dry conditions including backfilling arround structure and disposal of excavated material up to a distance of 1 Km.	cu.m	2,150	500	1,075,000
2	Providing and laying in situ Plain cement concrete Class C-10/20 using ordinary Portland cement in Structure manhole and elsewhere including formwork, mixing, pouring, levelling, compacting, vibrating and curing, complete as per drawings, specification and as directed by the Engineer.	cu.m	110	8,500	935,000
3	Providing and laying in situ Plain cement concrete Class C-30/20 using ordinary Portland cement in Structure manhole and elsewhere including formwork, mixing, pouring, levelling, compacting, vibrating and curing, complete as per drawings, specification and as directed by the Engineer.				
	i) In Base Slab and Footing	cu.m	500	9,000	4,500,000
	ii) In Walls and wing walls	cu.m	45	10,000	450,000
	iii) In Top Slab	cu.m	255	10,500	2,677,500
4	Providing, Placing and fixing in position Deformed steel reinforcement bars, confirming to BS 4449 or ASTM A-615 with minimum Yield strength of 420 N/mm^2 including cutting, bending, binding, straightening, wastage, overlaps, chairs and tying with binding wire complete, at any height and any floor as per design, drawings, specifications and as directed by the Engineer.	tonne	90	143,000	12,870,000
5	Providing and applying 2 coats of hot bitumen @ 1 kg per sq.m, each coat, to the concrete surfaces in contact with the earth and contraction joints, complete as directed by the Engineer.	sq.m	1,000	500	500,000
	CARRIED TO COLLECTION				23,007,500

BALOCHISTAN WATER RESOURCES DEVELOPMENT PROJECT

SIRI TOI DAM ZHOB RIVER BASIN

COST ESTIMATE

BILL NO - 11 : ROAD CULVERT (2 No.)

S.No.	PAGE NO	AMOUNT
1	B.O.Q PAGE NO - 32	23,007,500
CARRIED TO SUMMARY		23,007,500

BALOCHISTAN WATER RESOURCES DEVELOPMENT PROJECT

SIRI TOI DAM ZHOB RIVER BASIN

COST ESTIMATE

BILL NO - 12 : WASHING STRUCTURE (5 No.)

S.No.	ITEMS OF WORKS	UNIT	QUANTITY	RATE	AMOUNT
1	Excavation for Irrigation channel / Structures in all kinds of soils upto required depth (except hard rock) including all operations of site clearing, grubbing, dewatering of sub soil water, surface water, and other sources. Levelling, dressing and compacted the excavated surface including backfilling and disposal of excavated surplus material to designated disposal areas within 1 Km, all complete as per drawings, specifications and as directed by the Engineer.	cu.m	225	500	112,500
2	Providing and laying in situ R.C.C Class C-30/20 using ordinary Portland cement in washing structure and elsewhere including formwork, mixing, pouring, levelling, compacting, vibrating and curing, complete as per drawings, specification and as directed by the Engineer (Excluding Steel reinforcement)				
	i) In Foot Bridge	cu.m	2.00	10,000	20,000
3	Providing, Placing and fixing in position Deformed steel reinforcement bars, confirming to BS 4449 or ASTM A-615 with minimum Yield strength of 420 N/mm^2 including cutting, bending, binding, straightening, wastage, overlaps, chairs and tying with binding wire complete, at any height and any floor as per design, drawings, specifications and as directed by the Engineer.	tonne	0.32	143,000	45,760
4	Providing and laying in situ Plain cement concrete Class C-30/20 using ordinary Portland cement in Structure manhole and elsewhere including formwork, mixing, pouring, levelling, compacting, vibrating and curing, complete as per drawings, specification and as directed by the Engineer.				
	i) In Base Slab	cu.m	56	9,000	504,000
	CARRIED TO COLLECTION				682,260

BALOCHISTAN WATER RESOURCES DEVELOPMENT PROJECT

SIRI TOI DAM ZHOB RIVER BASIN

COST ESTIMATE

BILL NO - 12 : WASHING STRUCTURE (5 No.)

S.No.	ITEMS OF WORKS	UNIT	QUANTITY	RATE	AMOUNT
	ii) In Walls	cu.m	3	10,000	30,000
	iii) In Coping	cu.m	3	7,500	22,500
5	Rubble stone masonry in 1:3 CS Mortar with flush pointed joints in walls	cu.m	75	6,500	487,500
6	Providing and laying stone in soak pit , Complete as per drawing and as directed by	cu.m	23	3,000	69,000
7	Providing and applying 2 coats of hot bitumen @ 1 kg per sq.m, each coat, to the concrete surfaces in contact with the earth and contraction joints, complete as directed by the Engineer.	sq.m	18	500	9,000
8	Preparation of concrete surfaces and installation and fixing of compressible, self expanding cork filler for expansion joints	sq.m	15	4,500	67,500
9	Supplying and applying Safe elastic V or similar approved joint sealant in contraction and expansion joints	Rm	9	500	4,500
10	Providing and laying 150mm dia UPVC pipe , Complete as per drawing and as directed by the Engineer.	Rm	5	600	3,000
11	Providing and fixing galvanized iron shutters Size 300 X 75 mm including chain as shown in the drawing complete in all respect with all necessary accessories according to required shape and size.	No.	5	2,000	10,000
12	Providing and fixing galvanized iron frames to suit shutters of size as shown in the drawing complete in all respect with all necessary accessories according to required size.	No.	5	1,500	7,500
	CARRIED TO COLLECTION				710,500

BALOCHISTAN WATER RESOURCES DEVELOPMENT PROJECT

SIRI TOI DAM ZHOB RIVER BASIN

COST ESTIMATE

BILL NO - 12 : WASHING STRUCTURE (5 No.)

S.No.	PAGE NO	AMOUNT
1	B.O.Q PAGE NO - 34	682,260
2	B.O.Q PAGE NO - 35	710,500
	CARRIED TO SUMMARY	1,392,760

BALOCHISTAN WATER RESOURCES DEVELOPMENT PROJECT

SIRI TOI DAM ZHOB RIVER BASIN

COST ESTIMATE

BILL NO - 13 : CATTLE DRINKING TROUGH (5 No.)

S.No.	ITEMS OF WORKS	UNIT	QUANTITY	RATE	AMOUNT
1	Excavation in natural ground under dry conditions including backfilling arround structure and disposal of excavated material up to a distance of 1 Km.	cu.m	85	500	42,500
2	Providing and laying in situ Plain cement concrete Class C-30/20 using ordinary Portland cement in Structure manhole and elsewhere including formwork, mixing, pouring, levelling, compacting, vibrating and curing, complete as per drawings, specification and as directed by the Engineer.				
	i) In Base Slab	cu.m	15	9,000	135,000
	ii) In Walls	cu.m	1	10,000	10,000
	iii) In Coping	cu.m	0.12	7,500	900
3	Rubble stone masonry in 1:3 CS Mortar with flush pointed joints in walls	cu.m	4	6,500	26,000
4	Providing and applying 2 coats of hot bitumen @ 1 kg per sq.m, each coat, to the concrete surfaces in contact with the earth and contraction joints, complete as directed by the Engineer.	sq.m	1	500	500
5	Preparation of concrete surfaces and installation and fixing of compressible, self expanding cork filler for expansion joints	sq.m	2	4,500	9,000
6	Supplying and applying Safe elastic V or similar approved joint sealant in contraction and expansion joints	Rm	4	500	2,000
	CARRIED TO COLLECTION				225,900

BALOCHISTAN WATER RESOURCES DEVELOPMENT PROJECT

SIRI TOI DAM ZHOB RIVER BASIN

COST ESTIMATE

BILL NO - 13 : CATTLE DRINKING TROUGH (5 No.)

S.No.	PAGE NO	AMOUNT
1	B.O.Q PAGE NO - 37	225,900
	CARRIED TO SUMMARY	225,900

BALOCHISTAN WATER RESOURCES DEVELOPMENT PROJECT

SIRI TOI DAM ZHOB RIVER BASIN

COST ESTIMATE

BILL NO -15 :- PARAPET WALL

ITEM. No.	DESCRIPTION	UNIT	QUANTITY	RATE (Rs)	AMOUNT (Rs)
	DAM AND DYKE PARAPET WALL				
1	Concrete class 10/20 under Wall	Cu.m	60	8,000	480,000
2	Concrete class C 30/20 in Wall	Cu.m	1,582	12,000	18,985,155
3	Reinforcement (Grade - 60)	M. Ton	158	143,000	22,594,000
4	Sealant in expansion joints.	L.m	470	850	399,500
	Water stop in expansion / contraction / construction joint (Type A	L.m	410	3,300	1,353,000
5	Application for bond breaking compound at contraction joint.	Sq.m	1,000	1,100	1,100,000
	Performed filler in expansion joints	Sq.m	1,000	1,100	1,100,000
6	Providing and applying 2 coats of hot bitumen @ 1 kg per sq.m, each coat, to the concrete surfaces in contact with the earth and contraction joints, complete as directed by the Engineer.	sq.m	2,000	500	1,000,000
7	Supplying and applying Safe elastic V or similar approved joint sealant in contraction and expansion joints	Rm	1,000	500	500,000
	CARRIED TO COLLECTION				**47,511,655**

BALOCHISTAN WATER RESOURCES DEVELOPMENT PROJECT

SIRI TOI DAM ZHOB RIVER BASIN

COST ESTIMATE

BILL NO -15 :- PARAPET WALL

ITEM. No.	DESCRIPTION	UNIT	QUANTITY	RATE (Rs)	AMOUNT (Rs)
	APPROACH WALLS, ABUTMENTS (SPILLWAY WALL RAISING)				
8	Concrete class C 30/20 in walls.	Cu.m	500	12,000	6,000,000
9	Reinforcement (Grade - 60)	M. Ton	50	143,000	7,150,000
10	Sealant in expansion joints.	L.m	300	850	255,000
11	Performed filler in expansion joints	Sq.m	100	1,100	110,000
12	Providing and applying 2 coats of hot bitumen @ 1 kg per sq.m, each coat, to the concrete surfaces in contact with the	sq.m	250	500	125,000
13	Supplying and applying Safe elastic V or similar approved joint sealant in contraction and expansion joints	Rm	1,200	500	600,000
14	Water stop in expansion / contraction / construction joint (Type A)	L.m	200	3,300	660,000
	CARRIED TO COLLECTION				**14,900,000**

CARRIED TO SUMMARY	**62,411,655**

BALOCHISTAN WATER RESOURCES DEVELOPMENT PROJECT

SIRI TOI DAM ZHOB RIVER BASIN

COST ESTIMATE

BILL NO -15 :- PARAPET WALL

S.No.	PAGE NO	AMOUNT
1	B.O.Q PAGE NO - 38	47,511,655
2	B.O.Q PAGE NO - 39	14,900,000
	CARRIED TO SUMMARY	62,411,655

ADB TA-8800:PAK: BALOCHISTAN WATER RESOURCES DEVELOPMENT PROJECT

PPTA REPORT ON COMPLAINT OVER SIRI TOI/ TANGI WAR DAM CORE SUB-PROJE CT

(Date: 23rd to 24th May, 2017)

A. APPROACH

1. This with reference to a complaint registered by (i) Muhammad Karim, (ii) Haji Muhammad Khan and (iii) Haji Shah Baz Khan through email address Karimirrebzai@gmail.com.

2. In response to this complaint, the Chief Engineer BID has written a letter to the concerned Commissioner and Deputy Commissioner for looking into the matter. The letter is attached herewith as **Annex-I**.

3. In addition, to look into the matter, the PPTA Consultant Resettlement, Social & Gender Specialist along with Sub-Consultant for Integrated Survey visited the project site on 23rd May to 24th May, 2017. The team interacted with the Deputy Commissioner Zhob and Communities/beneficiaries falling in the command of the proposed Sri-Toi/Tangi War Dam. The findings are detailed in this report.

4. In the first day of meeting (i.e. 23rd May) with the Deputy Commissioner (DC) Zhob, the PPTA Team requested DC to facilitate the team with Patwari (Mr.Nawaz) and Qanoongo (Mr.Shahjehan) of Revenue Department Zhob to assess the land ownership in the light of revenue record transparently. Accordingly, the PPTA team was facilitated by DC with the Qanoongo and Patwari of Revenue Department Zhob for site visit. The Integrated Survey Team organized another meeting with the DC and Revenue Department on 6th June, 2017 to speed up the presenting of their report over the matter.

5. The visit was paid along with the communities/beneficiaries and revenue department concerned on the same day and the required cadastral record was obtained. The next day (i.e. 24th May) the team along with Tribal Jirga/Community Representatives (**see Table:1)** and Revenue Department concerned, again interacted with the DC to brief him about the findings of the site visit.

Table-1: Names of Community Representatives

S#	Name of Community Representative	Father's Name	Clan	Village Name
1	Qari Sana-Ul-Haq	Hazrat Abdul Haq	Ahmadkhel Karezi	Hazrat Sahib
2	Muhammad Zahid	Muhammad Rafiq	Arabzai Syedokhel	Sra Ghundi
3	Haji Abdul Rauf	Moulana Abdul Haq	Arabzai Syedokhel	Hazrat Sahib
4	Haji Rahim	Malik Dad Khan	Arabzai Syedokhel	Bobi Arabzai
5	Malik Haji Noor Khan	Muhammad Daraz	Arabzai Syedokhel	Nave Oba
6	Haji Muhammad Shafiq	Muhammad Rafiq	Arabzai Syedokhel	Sra Ghundi
7	Malik Muhammads Zaman Advocate	Malik Sultan Muhammad	Arabzai Syedokhel	Tora Darga

B. COMPLAINANT(s) GRIEVANCE STATUS

6. In the email, the complainant expressed following concerns with respect to designing and constructing of the proposed Sri Toi/Tangi War Dam in Zhob District of Balochistan as the status/response is given in the following **Table 2;**

Table-2: Status of Reported Grievances

S#	Grievances	Status
1	All the concerned parties working in the ambit I,e from social team to surveyor has been reporting the matter absolutely free of any reservation though the equitable land distribution in societies like ours will throw the stake holders into bloody feuds rather than bringing prosperity if not followed with justice . It is therefore requested that the land distribution among all the stake holders without any discrimination, according to tribal rites and rituals and the long agreed or new system whichever the elders decides should be carried in real, prior to keeping the very basic stone of the Dam otherwise we will request ADB let us according to our well existing situation and if it is carried without the consent of the stakeholders will produce serious consequences and then all will be answerable for this mishaps.	• As the project is to be implemented through participatory approach; therefore; the PPTA Team carried out the overall surveys (reconnaissance-topographic & detailed socio-economic) required for the feasibility of project with close coordination and consultation of the likely concerned beneficiaries. Without coordination and consultation with the concerned communities, none of the above step is possible and feasible. • The land distribution aspects are reported in pre-feasibility report of the PPTA Consultant. • As per TOR, the PPTA Consultant hired services of Sub-Consultant to undertake Integrated Surveys of all potential (39 in Zhob & Porali River Basins) and schemes selected for 100 million USD including the Sri Toi Dam. As the sub-project was selected as Core Sub-Project under the ADB BWRDP, accordingly; as per ADB SPS, frequent and meaningful consultation in the project area was carried out by the Integrated Survey Team of PPTA along with EA/ID staff based in Zhob to make aware the beneficiaries or likely affectees (if any) about the proposed development. This consultation will be part of the PPTA Social, Poverty & Gender Assessment Report. • During the Integrated Survey for the Sri Toi Core Sub-Project, about [1]**864** landholding households (settled in 17 villages) were recorded with the consultation of the local people who help in preparing/documenting the list of legal landholders in the command of the proposed dam. However; these concerns were not reported/ observed at all during the survey period. • This concern/issue was raised during the ADB workshop in Serena Hotel Quetta on 8th and 10th April, 2017 while the field survey was completed and accordingly it was made part of the pre-feasibility

[1] As revenue record is lastly updated around 1969-70 and the total number of landholders in the revenue record is 306. Therefore; the record is around 47 years old and The PPTA tam collected updated data of landholding households which is all over 864.

S#	Grievances	Status
		report and ***immediately the community/beneficiaries of Sri Toi/Tangi War Dam was sensitized to resolve the matter amicably.*** • The first complainant is settled in Quetta and status is non-resident. • In the light of the reported concern and reference of the Chief Engineer Balochistan Irrigation Department Letter to the concerned Commissioner and Deputy Commissioner, the PPTA team re-visited the site in consultation with the Deputy Commissioner and with the assistance of Patwari and Qanoongo of the Revenue Department Zhob on 23rd and 24th May, 2014. ***The findings are reported in the Section-C of this report***.
2	It has also been learnt through various meetings and discussions that this dam is used as a political mileage for some eminent figures of the day, it is requested that ADB should construct the same Dam at his or their own doorstep rather than throwing us, the very miserable corner into massacre.	• Before; selection of the Sri Toi/Tangiwar Dam sub-project, a long list of schemes was provided by the ID to select the potential schemes on the basis of a well-established multiple scheme selection criteria prepared by PPTA consultant in consultation with the Balochistan Irrigation Department. Therefore; this Sri Toi/Tangi War Dam sub-project is selected on the basis of abovementioned criteria rather than political grounds.
3	It is worth to mention here that the pre- feasibility survey report of the team says (sub project 3.3.1 86,87and 88) that the land is equitably distributed and says that the land owners are interested in Dam construction instead of the fact that the techno consultant and the aforementioned authorities have been sent mail at their mail addresses (which is sent to you as a ready reference) if these authorities may please be asked that they have ever gone through the mail or responded it.	• The land record is registered with the Revenue Department Zhob in the name of *Mouza Ahmadkhel Tappa Gastoi*. It is confirmed with the representative of the each Clan, that the land is distributed on the level of Caln as well as Segmentary lineage. As committed by the community, further distribution on the level of unit household is in progress likely to be completed before the commencement of the proposed project works. For clarification see Section-D as well as report of revenue department and DC Zhob in **Annex-III.**

S#	Grievances	Status
4	It is also hereby mentioned that the surveyors have been sent back by the grieved people if this incident is ever mentioned before, if not then the interest of these authorities may please be inquired that why are they reporting the matter on false statements .	• As reported above; after this complain in Serena in February, the communities/beneficiaries of the Sri Toi/Tangi War Dam was sensitized to resolve the matter, the PPTA Engineers with the Mr.Sharafgan (Superintending Engineer ID) visited the site and the this grievance was not raised again. Therefore; the Topographic Survey team was mobilized to undertake the survey in time.
5	It is imaginable that the command area is situated at the brink of sirtoi river with abundant underground water but there is not even one acre piece of land that has ever been cultivated is due to this fact that unless or until it is not distributed will be the same stretch of barren land or otherwise will be irrigated with blood by snatching precious lives of the poor masses, may God forbid.	As discussed above, the Tribal Jirga committed to accomplish the land distribution before commencement of the project works. In addition, there are two kind of water resources; perennial flow of the river and flash floods. In peak season, the perennial flow is not reaching to the whole command area except a small piece in the reservoir of the dam while the in context of flood water, the community does not have the capacity to diver the flood water for irrigation. For further clarification see report of Revenue Department and DC in Annex-II.
6	It is also mentioned here that the pre-feasibility survey say that the command area will be cultivated within three years, we assure here that it will never be cultivated unless it is distributed prior to dam construction.	As discussed above, most of the land is distributed on the level of Segmentary Lineage (**see Annex-II**). However; further distribution to the level of unit household is verbally committed by the Community Representatives/ tribal Jirga **(see Table-4**) to complete before the commencement of the project works.
7	The hon'ble project officer we are going to keep our concluding remarks or aim as follows and nothing less than that will be acceptable to us I) We are poor people and our main source of livelihood is pastoral economy since we have been sent to this earth and the dam body area solely belongs to us exclusive of other clans of irrebzai tribe, is the only area with perennial flow and	The dam reservoir is unsettled land and is currently ownership of the Hazarat Sahib village and they {Hazrat Sahib} have committed with the project team to dedicate this piece of land for the anticipated benefits of the proposed project without any compensation. In addition, there is an agreement reached in 2016 between the tribal elders of the project communities including the Mr.Shehbaz (who is only one complainant

S#	Grievances	Status
	lea/pastures for our animals and no involuntary/forced resettlement will be acceptable to us in case we are tried for involuntary resettlement will be approached through court.	had legal land rights in the Mouza Ahmadkhel) and they have committed to dedicate the land for the proposed dam. This agreement is substantiated over a legal stamp paper and reflected with this report as **Annex-III**.
II)	No dam will be acceptable without equitable land distribution and all the concerned line departments and wings working on the project are requested to pay heedful attention to this matter and refrain from throwing the feeble masses into tribal feuds and bloodshed or the motto of the ADB should not be at least the reason for the mishaps.	No involuntary resettlement is envisaged under the proposed dam plan. The acquisition of the land is required which has been cleared in the earlier statements. As discussed above, the Community Representatives/ Tribal Jirga committed to accomplish the land distribution before commencement of the project works.

C. PPTA FIELD FINGINS

1. The findings of the site visit and meeting with the DC is elaborated as follows;

    i. The land record of the project area is registered with the Revenue Department Zhob in the name of Mouza Ahmadkhel. As per revenue record, there are (**see Table:3**) Awaras in Mouza Amadkhel having following names and land size;

Table 3: Land Record/Name of Awaras & Distribution Status

S#	Name of Awara
1	Kali Zam
2	Kachi
3	Kashkalvi
4	Sawal Gari
5	Sakahni
6	Neknawal
7	Ismail Kachi
8	Mohbat Kachi
9	Maril Ghundi/Surki

S#	Name of Awara
10	Murgha Lakki/Doshana Ghara
11	Kaz Kalvi Kass
12	Dulat Aghbargi
13	Nikhal
14	Kazha Bala
15	Mulakhi
16	Suri Qamar
17	Spin Wah
18	Sur Naghar/Thor Thagham

Source: Revenue Department & Community Consultation

ii. The revenue record established on 19th November, 1969, reveals that the total registered land is [2]3,981 acres and 34 poles. The irrigated land is 91 acres and 38 poles while un-irrigated land is 3878 acres, 3 rods and 38 poles. The record indicates that most of the land under Mouza Ahmadkhel is distributed among the landholders.

iii. During site visit, the Patwari and Qanoongo of the Revenue Department Zhob declared the *proposed dam axis point and reservoir area* as unsettled. As per opinion of the Revenue Deparmtnet, the unsettled land rights go to the people settled in the area. As reported by the community of Hazrat Sahib Village, this piece of land is called *Bagheecha, Hazrat Sahib Bandat* or *Sara Kach* and currently ownership of Qari Sana-ul-Haq (Hazart Sahib Family). In the pat a flour mill was operating in this area. Reportedly, this piece of land has been purchased by Hazrat Sahib Family from Davi Clan of Arabzai Ahmad Khel. The Hazrat Sahib family voluntarily dedicated this piece of land for the proposed Sri Toi Dam Project in response of the anticipated benefits of the project.

iv. As per integrated survey conducted for the Core-Subproject, the main tribe living in the sub-project area belongs to the Arbzai clan of Mandokhail. The name of villages along with the number of land shareholders are given in the following **Table:4**;

Table 4: List of Villages along with No of Landholding Households and Population

Name of Scheme	S.No	Village Names	No of Water/Landholding Households	Population	Male	Female
Sri Toi Dam	1	Tora Darga	262	2725	1219	1506
	2	Killi Hazrat Sahib	48	2251	1070	1181
	3	Killi Surghundi	36	273	121	152
	4	**Killi Nave Oba**	75	548	230	318
	5	Killi Bobi Irrabzai	85	618	267	351
	6	Killi Ashai Kasi/Fakhri	15	87	39	48
	7	Killi Omvani Shpa	17	139	62	77
	8	Killi Gada Khel	61	1926	893	1033
	9	Killi Zawai	20	546	268	278
	10	Killi Tor Ghundi	37	559	277	282
	11	Killi Sunkasi	48	894	423	471

[2] The unsettled land is not part of this area.

Name of Scheme	S.No	Village Names	No of Water/Landholding Households	Population	Male	Female
	12	Killi Rodh Ahmadkhel	33	595	283	312
	13	Killi Doshana Hazrat Sahib	20	228	109	119
	14	Killi Landi Bobi	45	658	297	361
	15	Killi Loi Mina	29	347	156	191
	16	Killi Shahwaz	10	129	64	65
	17	Killi Qatal Khan	23	388	172	216
Total			**864**	**12911**	**5950**	**6961**

Source: Up-to-date information is collected with the consultation of the concerned Communities

v. The above table indicates that there are **864** land shareholders households with total population of 12911 heads. As per up-to-date progress over the matter, the complainants are only of three (03) out of 864. It indicates that the 861 households are in favor of the proposed dam while only 3 households are in disfavor.

vi. As reported by the community, the complainants are belonging to Davi clan of Arabzai Ahmed Khel is the owner of the land namely [3]*Swarlas Guni* situated on peaks of the mountains in the catchment of the proposed dam and *Sra* as well as *Nikhal* located downstream of the dam. None of these land falling in the [4]primary impact zones of the proposed dam. However; as per revenue department and DC report, only one complainant have share of land in the command area.

vii. In addition to the above, the community of the proposed dam project have formed a committee consisting of the tribal elders to be representing all clans will settle the matter through tribal approach. This step is anticipated to be taken immediately after Eid (at the end of June).

D. REPORT OF DEPUTY COMMISSIONER ZHOB

viii. As discussed earlier, in response to the Letter of Chief Engineer EA/ID to concerned Commissioner and Deputy Commissioner Zhob, accordingly; the Revenue Department and DC submitted their reports and is attached here with as **Annex-II.** Some of the key points of the report are illustrated below which support the above findings of the PPAT team that;

- The site for the proposed dam is unsettled land.
- The settled area in Mouza AHmadkhel is 3970 ha owned by the residents. About 8 ha is owned by the Government.
- The number of land owners (Patidaar) as per record is 307. It indicates that the land is distributed among the land owners.

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[3] Beyond Mouza Ahmadkhel.

[4] The zones/areas where the proposed engineering works like construction of dam axis, dyke, spillway and irrigation canals will be carried out.

- The report reveals that the complainants are only 3 out of the total landholders.
- The complainants Mr.Muhammad Karim and Muhammad Khan do not have land right in the Mouza/project area. Only complainant Mr.Shehbaz had 2 ha of registered land in Mouza.
- The project area had thousands of unsettled land and the dam site is located in that piece of land.
- Furthermore; the report of DC is providing legal guidance that in case, if a person does not have land share in Mouza, then the same person does legally not deserve for the communal land (*Shamilaat*) in the same Mouza.

Annex-I

LETTER OF CHIEF ENGINEER EA/ID TO COMMISSIONER & DEPUTY COMMISSIONER ZHOB

OFFICE OF THE CHIEF ENGINEER (NORTH)
GOVERNMENT OF BALOCHISTAN
IRRIGATION DEPARTMENT

No DB 49-2533-41 Dated Quetta, the 18 / 05 2017

To

The Commissioner,
Zhob Division at Loralai.

Subject: **CONSTRUCTION OF TANGI WAR DAM IN SRI TOI AREA DISTRICT ZHOB.**

Reference :- Application submitted by Mr. Muhammad Karim and others residents of Siri Toi area district Zhob on the subject (Copy attached for ready reference).

Please be informed that Feasibility study of subject dam is being carried out under the PPTA (8800) Grant of Asian Development Bank which is expected to be matured at the end of July 2017 for further consideration and construction under the Asian Development Bank Credit agreed with the Government of Balochistan.

There are two River Basins (Zhob and Mula) that have been selected with the objective for Development of Water Resources in Balochistan after conducting detailed field surveys and investigations by the Consultants hired by the Asian Development Bank.

The Consultants after carrying out field surveys of about 40 schemes finalized 05 schemes in Zhob River Basin and 06 schemes in Mula River Basin with the consultation and consent of ADB, Irrigation and Agriculture Department Government of Balochistan.

The proposed Tangi War Storage Dam would be the most potential Project among the five selected schemes in Zhob basin where even availability of sufficient quantity of water no agriculture exists in the area due to non- availability of Water Storage reservoirs and Irrigation facilities.

The applicants Muhammad Kareem and other vide their above referred application pleaded that the lands of the Project area is un-settled and the subject dam is not acceptable to them without equitable land distribution falls under Dam's Structures, Reservoir and Command area.

It is also imperative to mention here that the Consultants team and the Executive Engineer Irrigation Division Zhob had already reported the situation to the Civil administration Zhob while realizing the situation at the initial stage of site investigations as well as the tribal elders /

beneficiaries of the Project area to settle-down their issues, who ensured that they will settle the matter amicably.

It is emphasized that the conservation of Water through construction of Dam for sustainable Domestic water supplies, Agriculture Development, Live Stock holdings is vital to up left the Socio economic conditions of the Project area.

It is therefore requested to kindly intervene in the matter for early settlement of the dispute in accordance with the realistic ground situation as the Feasibility Study of the subject Dam is at the final stage of completion.

(SYED PERVEZ BUKHARI)
CHIEF ENGIEER (NORTH)
IRRIGATION DEPARTMENT

Copy to:

1. The Secretary, Irrigation Department Government of Balochistan, Quetta
2. The Registrar Honorable High Court Balochistan with reference to the CP- 948
   for their information please.
3. The Superintending Engineer Zhob Irrigation Circle at Loralai.
4. The Deputy Commissioner District Zhob.
5. The Executive Engineer Irrigating Division Zhob.
   for their information and necessary action please.
6. The Team Leader TCI Consultants Karachi
7. Mr. Wahid, Coordinator Asian Development Bank Quetta.

Annex-II

REPORT OF REVENU DEPARTMENT AND DEPUTY COMMISSIONER ZHOB

Phone : 0822 - 412400 / 412399
Fax : 0822 – 413388

OFFICE OF
THE DEPUTY COMMISSIONER, Z H O B.

No. Revenue Br./ Irrigation / 2017.
Dated Zhob the June 9th, 2017.

The Commissioner,
Zhob Division at LORALAI.

Subject: **CONSTRUCTION OF TANGI WAR DAM IN SRA-TOI AREA OF DISTRICT ZHOB.**

Kindly refer to a letter No. DB-49-2533-41 Dated 18th May 2017, addressed to your good office and endorsed a copy thereof to this office among others along-with its enclosures, received from office of the Chief Engineer (North), Government of Balochistan, Irrigation Department on the captioned subject.

Reasons for writing the said letter to your good office:

Your kind attention has been invited by the Irrigation Department Government of Balochistan for ensuring the resolution of the subject matter without any potential hurdles/obstacles or observations in a befitting way.

Analyzing contents of the application:

This office went through the contents of the application submitted to Chief engineer (North) Irrigation Department on the captioned subject by complainants/applicants (Mr. Muhammad Karim & others) thoroughly and analyzed their claims/demands/reservations keeping in view the Land Revenue record available in this office and a report to this effect was sought from the concerned Revenue staff, which reveals that ;-

(i) The site for the proposed Dam falls under the unsettled area of "Mouza Ahmedkhel" sub-tehsil Samabzah, district Zhob.

(ii) The settled area of the said 'Mouza' is 3970 hectors (owned by the residents of the area), in addition to 8-hectors more area owned by the Government (Total settled area is 3970+8=3978-Hectors).

(iii) The number of the Patti Daars (real settled owners) of the 'Mouza' is 307.

(iv) The instant applicants/claimants are three (3) viz, Muhammad Kareem s/o Muhammad Din son of Safar, Muhammad Khan s/o Juma Gul s/o Raz Gul and thirdly Shahbaz s/o Zarghoon s/o Baran – all by caste Davikhel-Ahmedkhel-Erabzai-Mandokhel.

(v) The former two applicants do not own even a single inch of settled-land of the 'Mouza' besides, having just ancestral pedigree therein. Yet, the latter (3rd last) applicant's ancestors own just two (2) Hectors of settled land of the said 'Mouza'.

(vi) The said 'Mouza' consist of thousands of un-settled land and the proposed site-selection is therein.

(Continued.......................)

(vii) The total under-cultivation area of the settled-land of the 'Mouza' is only two (2) percent whereas 98% of the settled area of the Mouza is un-cultivated so far.

(viii) Out of total 307 Patti Daars just one Patti Dar being the owner of just two hectors of settled land challenges the construction of the Dam, whereas, the rest 306-Patti Daars being the owners of the rest 3976-Hectors have so far shown no un-willingness on the record, so, in other words they hesitantly await welcoming to the said project.

Guidance from land Revenue Act-1967.

(i) If a resident does not own any settled land of a 'Mouza', then, he cannot claim ownership of the 'Shamilati' or un-settled land of the said 'Mouza'. Same is the case with the former two claimants/applicants (viz, Mr. Kareem-representative of the applicants and Mr. Mohammad Khan).

(ii) No doubt, the ancestors of the third applicant (Mr. Shahbaz) own just two Hectors of settled land. So, on the one hand, there are 306-Owners of about 3976-Hectors of settled land of the 'Mouza' welcoming the said project whereas on the other hand, there is just one owner of just two Hectors of the settled land, challenges the said project.

(iii) Natural justice does demand of one's right/privileges and same is the case here with Mr. Shahbaz (applicant-owner of the two Hectors of settled land). His grievances would be considerable if the proposed site consisted of all the available un-settled land of the 'Mouza', but the fact is not so and still thousands of Hectors do remain untouched wherein he can avail himself of that to the extent of the concerned rule.

(iv) Having no settled-land, thus being non-Patti Daars Mr. Muhammad Kareem and Mr. Muhammad Khan are irrelevant guys to the extent of challenging/opposing the construction of the Dam. Yet, they are relevant just in the sense of having 'Pedigree' of the said 'Mouza' who if legally necessary may be adjusted in the rest of thousands of the un-settled land other than the proposed site.

Thus, keeping in view the aforementioned facts/figures it is requested that the quarter concerned may kindly be conveyed to proceed with as per their devised plan so that the interests of hundreds of thousands of masses and that of their future generations could be protected on a large scale. *(The relevant copies are attached for ready reference please).*

(MUHAMMAD AZEEM KAKAR)
Deputy Commissioner,
Z H O B.

C. C;-

1. The Superintending Engineer, Irrigation Department, Zhob Division.
2. Master file.

بابت دربارہ [illegible] ڈیم میں موجودہ ایریا
موضع احمد خیل [illegible] تحصیل [illegible] ضلع [illegible]

جناب عالی،

گزارش ہے کہ اس سے قبل [illegible] نمائندگان
ایریگیشن [illegible] ہمراہ [illegible] قانونگو حسب الحکم [illegible]
[illegible] موقع کا [illegible] کیا گیا تھا۔ بمطابق
موقعہ جہاں [illegible] ڈیم ہے مذکورہ ایریا
موضع احمد خیل [illegible] موجودہ ایریا ہے۔ یہ واضح ہو کہ
مذکورہ ڈیم ایریا کے متعلق ہی داران [illegible] احمد خیل
[illegible] اور [illegible] شاخ [illegible]
[illegible] احمد خیل
شاخ [illegible] اور [illegible] داران [illegible]
صرف [illegible] ایک ہی فرد [illegible] نامی شخص اپنے ساتھیوں کے ساتھ
[illegible] جو کہ قوم [illegible] کے ساتھ مذاق ہے
[illegible] ایریا ڈیم ایریا سے میلوں دور [illegible] ہے۔ [illegible] شخص
[illegible] ایریا میں موجود ہے۔ صرف ایک شخص کو فائدہ ڈیم سے نہیں
[illegible] ہزاروں اشخاص [illegible] ہزاروں ایکڑوں
[illegible] ہوگا۔ [illegible]

[illegible]
06-06-2017

منجانب: تحصیلدار ژوب
بجانب: بخدمت جناب ڈپٹی کمشنر ژوب
نمبر 256
تاریخ 06/2017

عنوان: ترسیل رپورٹ تنگی ور ڈیم
ضلع احمد خیل کنبل ضلع ژوب

عالی! گزارش خدمت ہے کہ بعنوان بالا تنگی ور ڈیم
کے بارے رپورٹ گوش گزار خدمت ہے۔ مذکورہ ڈیم
ایک قومی علاقائی ترقی کا سنگ میل ہے۔ مذکورہ ڈیم سے
لوگ علاقہ کی ترقی وابستہ ہے حالیہ دور میں حکومت
زراعت کی ترقی کے لیے کوشاں ہے۔ اور حکومت زرعی انقلاب
لانا چاہتا ہے حکومت کافی سرمایہ مذکورہ ڈیم پر
خرچ کرنا چاہتا ہے۔ تمام قوم منزخیل داخل علاقہ مذکورہ ڈیم کی
تعمیر کے خواہشمند ہیں اور صرف کسی ایک فرد/شخص کی
رکاوٹ کی وجہ سے ایسے اہم منصوبہ کو روکنا ظلم کے مترادف ہے۔
مذکورہ ڈیم کی تعمیر کی منظوری کے لیے حکام بالا کو سفارش کی جاتی ہے۔
آنجناب مہربانی کر کے گزارش اطلاع و احکامات صادر

Mohammad
6/6/017
تحصیلدار ژوب

Annex-III

COMMUNITY AGREEMENT OVER LEGAL STAMP PAPER

Rupees 15

۱۵ روپیہ

فیصلہ دوبارہ

[illegible]

جو اپنے معاملہ تعمیر شنگ ورم [illegible] پانی [illegible]

[illegible]

[illegible]

آپس میں [illegible] تقسیم کرنے کا پابند ہوں گے -

۲ ، چونکہ شنگ ورم میں [illegible] آپس میں مشترکہ ہیں وہ [illegible] شنگ ورم

میں جو پانی [illegible] ہو گیا اور [illegible] ورم کا [illegible] پانی [illegible]

اور [illegible] ہو گیا - [illegible]

اپنے [illegible] کا ثبوت [illegible] پیش کرنے کا پابند ہو گا - ثبوت [illegible]

[illegible] ہو گیا - [illegible]

تعداد ہر ورم کا [illegible] تقسیم ہو گیا -

ان قبیلوں میں حضرت [illegible]

[illegible]

[illegible]

[illegible] - [illegible] . مورخہ 30.12.2016

العبد
[illegible] ولد

العبد
حاجی [illegible]

العبد
قاری ثناء الحق [illegible]

العبد
حاجی [illegible] ولد [illegible]

العبد
حاجی [illegible] ولد [illegible]

العبد
عبد اللہ ولد [illegible] اللہ

[illegible] ولد [illegible] — [illegible] ولد [illegible] — [illegible]

[illegible] ولد [illegible] — حاجی [illegible] ولد حاجی [illegible] خان — ثناالله ولد کریم

[illegible] ولد [illegible] — حاجی [illegible] ولد [illegible] یار — حاجی [illegible] ولد حبیب [illegible]

[illegible]

[illegible] ولد [illegible] خان — [illegible] ولد حاجی [illegible] — سید ولد [illegible]

NOVEMBER 2017

GOVERNMENT OF BALOCHISTAN

BALOCHISTAN WATER RESOURCES DEVELOPMENT PROJECT
ZHOB RIVER BASIN

SIRI TOI DAM

F E A S I B I L I T Y D R A W I N G S

APPENDIX A

ADB ASIAN DEVELOPMENT BANK

Consultant
Techno-Consult International

16-E, Block-6, P.E.C.H.S, Karachi 75400, Tel: 92-21-3430-2877-78, Fax: 92-21-3430-2879, email: info@waterdivision.com.pk, web: www.waterdivision.com.pk

A. GENERAL DRAWING

SN.	DRAWING NO.	TITLE
1.	BWRDP-ZRB-STD-GD-001	LIST OF DRAWINGS
2.	BWRDP-ZRB-STD-GD-002	GENERAL NOTES
3.	BWRDP-ZRB-STD-GD-003	PROJECT LOCATION MAP
4.	BWRDP-ZRB-STD-GD-004	AREA CAPACITY CURVE / CLIMATOLOGICAL DATA AND RUN OFF
5.	BWRDP-ZRB-STD-GD-005	PROJECT LAYOUT PLAN
6.	BWRDP-ZRB-STD-GD-006	RESERVOIR AREA LAYOUT PLAN
7.	BWRDP-ZRB-STD-GD-007	SETTING OUT DATA

B. MAIN DAM

SN.	DRAWING NO.	TITLE
8.	BWRDP-ZRB-STD-MD-101	MAIN DAM - LAYOUT PLAN
9.	BWRDP-ZRB-STD-MD-102	MAIN DAM - LONGITUDINAL SECTION
10.	BWRDP-ZRB-STD-MD-103	MAIN DAM - TYPICAL CROSS SECTION
11.	BWRDP-ZRB-STD-MD-151	MAIN DAM - CROSS SECTION AT STATION 0+000 & 0+020
12.	BWRDP-ZRB-STD-MD-152	MAIN DAM - CROSS SECTION AT STATION 0+040 & 0+060
13.	BWRDP-ZRB-STD-MD-153	MAIN DAM - CROSS SECTION AT STATION 0+080 & 0+100
14.	BWRDP-ZRB-STD-MD-154	MAIN DAM - CROSS SECTION AT STATION 0+120 & 0+140
15.	BWRDP-ZRB-STD-MD-155	MAIN DAM - CROSS SECTION AT STATION 0+160 & 0+180
16.	BWRDP-ZRB-STD-MD-156	MAIN DAM - CROSS SECTION AT STATION 0+200 & 0+220
17.	BWRDP-ZRB-STD-MD-157	MAIN DAM - CROSS SECTION AT STATION 0+231.36 (END)

C. DYKE

SN.	DRAWING NO.	TITLE
18.	BWRDP-ZRB-STD-DY-201	DYKE - LAYOUT PLAN
19.	BWRDP-ZRB-STD-DY-202	DYKE - LONGITUDINAL SECTION
20.	BWRDP-ZRB-STD-DY-203	DYKE - TYPICAL CROSS SECTION
19.	BWRDP-ZRB-STD-DY-251	DYKE - CROSS SECTION AT STATION 0+000 & 0+020
20.	BWRDP-ZRB-STD-DY-252	DYKE - CROSS SECTION AT STATION 0+040 & 0+060
21.	BWRDP-ZRB-STD-DY-253	DYKE - CROSS SECTION AT STATION 0+080 & 0+100
22.	BWRDP-ZRB-STD-DY-254	DYKE - CROSS SECTION AT STATION 0+120 & 0+140
23.	BWRDP-ZRB-STD-DY-255	DYKE - CROSS SECTION AT STATION 0+160 & 0+180
24.	BWRDP-ZRB-STD-DY-256	DYKE - CROSS SECTION AT STATION 0+200 & 0+220
25.	BWRDP-ZRB-STD-DY-25	DYKE - CROSS SECTION AT STATION 0+234.67

D. SPILLWAY

SN.	DRAWING NO.	TITLE
26.	BWRDP-ZRB-STD-SP-301	SPILLWAY - LAYOUT PLAN
27.	BWRDP-ZRB-STD-SP-302	SPILLWAY - LONGITUDINAL SECTION
28.	BWRDP-ZRB-STD-SP-351	SPILLWAY - CROSS SECTIONS AT STATION -0+330, -0+320 & -0+310
29.	BWRDP-ZRB-STD-SP-352	SPILLWAY - CROSS SECTIONS AT STATION -0+300, -0+290 & -0+280
30.	BWRDP-ZRB-STD-SP-353	SPILLWAY - CROSS SECTIONS AT STATION -0+270, -0+260 & -0+250
31.	BWRDP-ZRB-STD-SP-354	SPILLWAY - CROSS SECTIONS AT STATION -0+240, -0+230 & -0+220
32.	BWRDP-ZRB-STD-SP-355	SPILLWAY - CROSS SECTIONS AT STATION -0+210, -0+200 & -0+190
33.	BWRDP-ZRB-STD-SP-356	SPILLWAY - CROSS SECTIONS AT STATION -0+180, -0+170 & -0+160
34.	BWRDP-ZRB-STD-SP-357	SPILLWAY - CROSS SECTIONS AT STATION -0+150, -0+140 & -0+130
35.	BWRDP-ZRB-STD-SP-358	SPILLWAY - CROSS SECTIONS AT STATION -0+120, -0+110 & -0+100
36.	BWRDP-ZRB-STD-SP-359	SPILLWAY - CROSS SECTIONS AT STATION -0+090, -0+080 & -0+070
37.	BWRDP-ZRB-STD-SP-360	SPILLWAY - CROSS SECTIONS AT STATION -0+060, -0+050 & -0+040
38.	BWRDP-ZRB-STD-SP-361	SPILLWAY - CROSS SECTIONS AT STATION -0+030, -0+020 & -0+010
39.	BWRDP-ZRB-STD-SP-362	SPILLWAY - CROSS SECTIONS AT STATION 0+000, 0+010 & 0+020
40.	BWRDP-ZRB-STD-SP-363	SPILLWAY - CROSS SECTIONS AT STATION 0+030, 0+040 & 0+050
41.	BWRDP-ZRB-STD-SP-364	SPILLWAY - CROSS SECTIONS AT STATION 0+060, 0+070 & 0+080
42.	BWRDP-ZRB-STD-SP-365	SPILLWAY - CROSS SECTIONS AT STATION 0+090, 0+100 & 0+110
43.	BWRDP-ZRB-STD-SP-366	SPILLWAY - CROSS SECTIONS AT STATION 0+120, 0+130 & 0+140
44.	BWRDP-ZRB-STD-SP-367	SPILLWAY - CROSS SECTIONS AT STATION 0+150, 0+160 & 0+170
45.	BWRDP-ZRB-STD-SP-368	SPILLWAY - CROSS SECTIONS AT STATION 0+180, 0+190 & 0+200
46.	BWRDP-ZRB-STD-SP-369	SPILLWAY - CROSS SECTIONS AT STATION 0+210, 0+220, 0+230 & 0+240
47.	BWRDP-ZRB-STD-SP-370	SPILLWAY - CROSS SECTIONS AT STATION 0+250, 0+260, 0+270 & 0+275

E. INTAKE STRUCTURE, ACCESS CONDUIT, STEEL PIPE & OUTLET WORKS

SN.	DRAWING NO.	TITLE
48.	BWRDP-ZRB-STD-OW-401	INTAKE STRUCTURE & ACCESS CONDUIT - LAYOUT PLAN
49.	BWRDP-ZRB-STD-OW-402	INTAKE STRUCTURE & ACCESS CONDUIT - LONGITUDINAL SECTION (IN MAIN DAM) & DETAILS
50.	BWRDP-ZRB-STD-OW-403	INTAKE STRUCTURE - DETAILS A & B
51.	BWRDP-ZRB-STD-OW-404	ACCESS CONDUIT - FILTER ARRANGEMENT & GATE CHAMBER
52.	BWRDP-ZRB-STD-OW-405	STEEL PIPE - PLAN & PROFILE OF 0+000 TO 0+400
53.	BWRDP-ZRB-STD-OW-406	STEEL PIPE - PLAN & PROFILE OF 0+400 TO 0+800
54.	BWRDP-ZRB-STD-OW-407	STEEL PIPE - PLAN & PROFILE OF 0+800 TO 1+200
55.	BWRDP-ZRB-STD-OW-408	STEEL PIPE - PLAN & PROFILE OF 1+200 TO 1+600
56.	BWRDP-ZRB-STD-OW-409	STEEL PIPE - ANCHOR BLOCK & PIPE SUPPORT DETAILS
57.	BWRDP-ZRB-STD-OW-451	ARRANGEMENT PLAN OF STEEL PIPE-CONTROL ROOM-ENERGY DISSIPATOR-TAILRACE CHANNEL-DISTRIBUTOR STRUCTURE-RC CHANNELS
58.	BWRDP-ZRB-STD-OW-452	OUTLET WORKS - VALVES CONTROL ROOM PLAN & SECTIONS
59.	BWRDP-ZRB-STD-OW-453	OUTLET WORKS - ENERGY DISSIPATER PLAN & SECTIONS
60.	BWRDP-ZRB-STD-OW-454	OUTLET WORKS - TAILRACE CHANNEL PLAN & SECTION
61.	BWRDP-ZRB-STD-OW-455	OUTLET WORKS - DISTRIBUTOR STRUCTURE DETAIL PLAN
62.	BWRDP-ZRB-STD-OW-456	OUTLET WORKS - DISTRIBUTOR STRUCTURE SECTION A-A & B-B
63.	BWRDP-ZRB-STD-OW-457	OUTLET WORKS - DISTRIBUTOR STRUCTURE SECTION C-C, D-D & E-E
64.	BWRDP-ZRB-STD-OW-458	OUTLET WORKS - RC CHANNEL PLAN & PROFILE

F. PLAN & PROFILE OF IRRIGATION CANAL

SN.	DRAWING NO.	TITLE
65.	BWRDP-ZRB-STD-PP-501	IRRIGATION SYSTEM LAYOUT PLAN
66.	BWRDP-ZRB-STD-PP-502	RIGHT CANAL LINE DIAGRAM
67.	BWRDP-ZRB-STD-PP-503	RIGHT CANAL PLAN AND PROFILE OF 0+000 TO 1+500
68.	BWRDP-ZRB-STD-PP-504	RIGHT CANAL PLAN AND PROFILE OF 1+500 TO 3+000
69.	BWRDP-ZRB-STD-PP-505	RIGHT CANAL PLAN AND PROFILE OF 3+000 TO 4+500
70.	BWRDP-ZRB-STD-PP-506	RIGHT CANAL PLAN AND PROFILE OF 4+500 TO 6+000
71.	BWRDP-ZRB-STD-PP-507	RIGHT CANAL PLAN AND PROFILE OF 6+000 TO 7+500
72.	BWRDP-ZRB-STD-PP-508	RIGHT CANAL PLAN AND PROFILE OF 7+500 TO 9+000
73.	BWRDP-ZRB-STD-PP-509	RIGHT CANAL PLAN AND PROFILE OF 9+000 TO 10+500
74.	BWRDP-ZRB-STD-PP-510	RIGHT CANAL PLAN AND PROFILE OF 10+500 TO 12+000
75.	BWRDP-ZRB-STD-PP-511	RIGHT CANAL PLAN AND PROFILE OF 12+000 TO 13+500
76.	BWRDP-ZRB-STD-PP-512	RIGHT CANAL PLAN AND PROFILE OF 13+500 TO 15+000
77.	BWRDP-ZRB-STD-PP-513	RIGHT CANAL PLAN AND PROFILE OF 15+000 TO 16+500
78.	BWRDP-ZRB-STD-PP-514	RIGHT CANAL PLAN AND PROFILE OF 16+500 TO 18+000
79.	BWRDP-ZRB-STD-PP-515	RIGHT CANAL PLAN AND PROFILE OF 18+000 TO 19+700
80.	BWRDP-ZRB-STD-PP-516	LEFT CANAL LINE DIAGRAM
81.	BWRDP-ZRB-STD-PP-517	LEFT CANAL-PLAN AND PROFILE OF 0+000 TO 1+500
82.	BWRDP-ZRB-STD-PP-518	LEFT CANAL-PLAN AND PROFILE OF 1+500 TO 3+000
83.	BWRDP-ZRB-STD-PP-519	LEFT CANAL-PLAN AND PROFILE OF 3+000 TO 4+500
84.	BWRDP-ZRB-STD-PP-520	LEFT CANAL-PLAN AND PROFILE OF 4+500 TO 6+000
85.	BWRDP-ZRB-STD-PP-521	LEFT CANAL-PLAN AND PROFILE OF 6+000 TO 7+500
86.	BWRDP-ZRB-STD-PP-522	LEFT CANAL-PLAN AND PROFILE OF 7+500 TO 9+000
87.	BWRDP-ZRB-STD-PP-523	LEFT CANAL-PLAN AND PROFILE OF 9+000 TO 10+500
88.	BWRDP-ZRB-STD-PP-524	LEFT CANAL PLAN AND PROFILE OF 10+500 TO 12+000
89.	BWRDP-ZRB-STD-PP-525	LEFT CANAL PLAN AND PROFILE OF 12+000 TO 13+500
90.	BWRDP-ZRB-STD-PP-526	LEFT CANAL PLAN AND PROFILE OF 13+500 TO 15+000
91.	BWRDP-ZRB-STD-PP-527	LEFT CANAL PLAN AND PROFILE OF 15+000 TO 16+500
92.	BWRDP-ZRB-STD-PP-528	LEFT CANAL PLAN AND PROFILE OF 16+500 TO 18+000
93.	BWRDP-ZRB-STD-PP-529	LEFT CANAL PLAN AND PROFILE OF 18+000 TO 19+500
94.	BWRDP-ZRB-STD-PP-530	LEFT CANAL PLAN AND PROFILE OF 19+500 TO 21+000
95.	BWRDP-ZRB-STD-PP-531	LEFT CANAL PLAN AND PROFILE OF 21+000 TO 22+500
96.	BWRDP-ZRB-STD-PP-532	LEFT CANAL PLAN AND PROFILE OF 22+500 TO 24+165

G. APPURTENANT STRUCTURES ON IRRIGATION CANAL

SN.	DRAWING NO.	TITLE
97.	BWRDP-ZRB-STD-ST-601	TYPICAL CANAL SECTION
98.	BWRDP-ZRB-STD-ST-602	CONTRACTION & EXPANSION JOINTS
99.	BWRDP-ZRB-STD-ST-603	OFF-TAKE STRUCTURE
100.	BWRDP-ZRB-STD-ST-604	FALL STRUCTURE
101.	BWRDP-ZRB-STD-ST-605	FALL STRUCTURE TABLE
102.	BWRDP-ZRB-STD-ST-606	AQUEDUCT
103.	BWRDP-ZRB-STD-ST-607	SIPHON
104.	BWRDP-ZRB-STD-ST-608	DRAINAGE CULVERT
105.	BWRDP-ZRB-STD-ST-609	ROAD CULVERT
106.	BWRDP-ZRB-STD-ST-610	WASHING STRUCTURE
107.	BWRDP-ZRB-STD-ST-611	CATTLE DRINKING TROUGH
108.	BWRDP-ZRB-STD-ST-612	DRINKING WATER STORAGE TANK

H. ACCESS ROAD

SN.	DRAWING NO.	TITLE
109.	BWRDP-ZRB-STD-AR-701	ACCESS ROAD - LAYOUT PLAN
110.	BWRDP-ZRB-STD-AR-702	ACCESS ROAD - TYPICAL CROSS SECTIONS

I. RIVER DIVERSION

SN.	DRAWING NO.	TITLE
111.	BWRDP-ZRB-STD-RD-801	STAGE-I LAYOUT PLAN & TYPICAL CROSS SECTION
112.	BWRDP-ZRB-STD-RD-802	STAGE-II LAYOUT PLAN & TYPICAL CROSS SECTIONS

J. INSTRUMENTATION

SN.	DRAWING NO.	TITLE
113.	BWRDP-ZRB-STD-INS-901	INSTRUMENTATION ARRANGEMENT PLAN OF MAIN DAM
114.	BWRDP-ZRB-STD-INS-911	INSTRUMENTATION ARRANGEMENT PLAN OF DYKE

CLIENT : ADB ASIAN DEVELOPMENT BANK

CONSULTANT: Techno-Consult International (Pvt.) Ltd.

PROJECT: BALOCHISTAN WATER RESOURCES DEVELOPMENT PROJECT (TA)

SCHEME: SIRI TOI DAM ZHOB RIVER BASIN

DRAWING TITLE : LIST OF DRAWINGS

Designed By :	-	Date :	NOVEMBER 2017
Drawn By :	ARSALAN RAFAT	Scale :	-
Checked By :	ZAFAR MASOOD SIDDIQUE	Drg No :	
Approved By :	DR BASHIR LAKHANI		BWRDP-ZRB-STD-GD-001

No.	Revision	By	Date

GENERAL NOTES

A. GENERAL

1. All dimensions and elevations shown on the Drawings are in Meters or Millimeters unless otherwise noted.
2. Grid, Co-ordinates of points and contours are in Meters.

B. EARTHWORK

1. Excavation shall be carried to the lines and grades as shown on the drawings or as directed by the Engineer.

2. Backfill and Selected fill material where required, shall be placed and compacted to the requirements as per technical specification and drawings.

3. Any loose soil encountered during excavation of canal or structure foundations, shall be replaced with approved fill material.

4. The Contractor should keep the excavated area dry during construction activity and at least 12 hours after concreting or as directed by the Engineer.

C. CONCRETE

1. Concrete design and construction shall conform to the provisions of the latest Version of building code requirement for structural concrete code-ACI 318.

2. Unless otherwise noted on the drawings, the minimum compressive cylinder strength f'c of concrete at 28 days shall be as follows:

   i) Class C - 30/20 33.5 MPa (4850 Psi) structural concrete
   ii) Class C - 10/20 12 MPa (1750 Psi) lean concrete
3. Ordinary Portland cement shall be used in all types of concrete unless otherwise specified.

4. Concrete finishes and tolerances shall be as per Technical Specifications.

D. REINFORCEMENT

1. Reinforcement steel indicated on drawings shall conform to ASTM:A615 Grade 50 deformed bars except # 3 bars which should be of ASTM:A515 grade 40.

2. Minimum concrete cover to reinforcement. unless otherwise noted, Shalll be:

25mm	Bottom reinforcement.
75mm	Face on contact with earth.
62.5mm	Beams, diaphragms deck slab (top reinforcement)
20mm	Hand railing

3. Wherever required, the lap and embedment will be according to the following table all laps shall be staggered.

LAP / EMBEDMENT LENGTHS FOR TENSION

Bar Size	(#)	T10	T13	T15	T20	T22	T25	T28	T31	T34
Lap Lengths	(mm)	300	350	450	500	825	1075	1375	1725	2125
Embedment Lengths	(mm)	300	350	300	375	252	675	850	1075	1325

LAP / EMBEDMENT LENGTHS FOR COMPRESSION

Bar Size	(#)	T10	T13	T15	T20	T22	T25	T28	T31	T34
Lap Lengths	(mm)	300	300	375	450	252	600	675	775	850
Embedment Lengths	(mm)	300	300	300	300	300	275	325	350	400

4. All reinforcement steel shall be accurately placed in the formwork and held firmly before placing concrete by means of 15 gauge black annealed wires and adequately designed spacers.

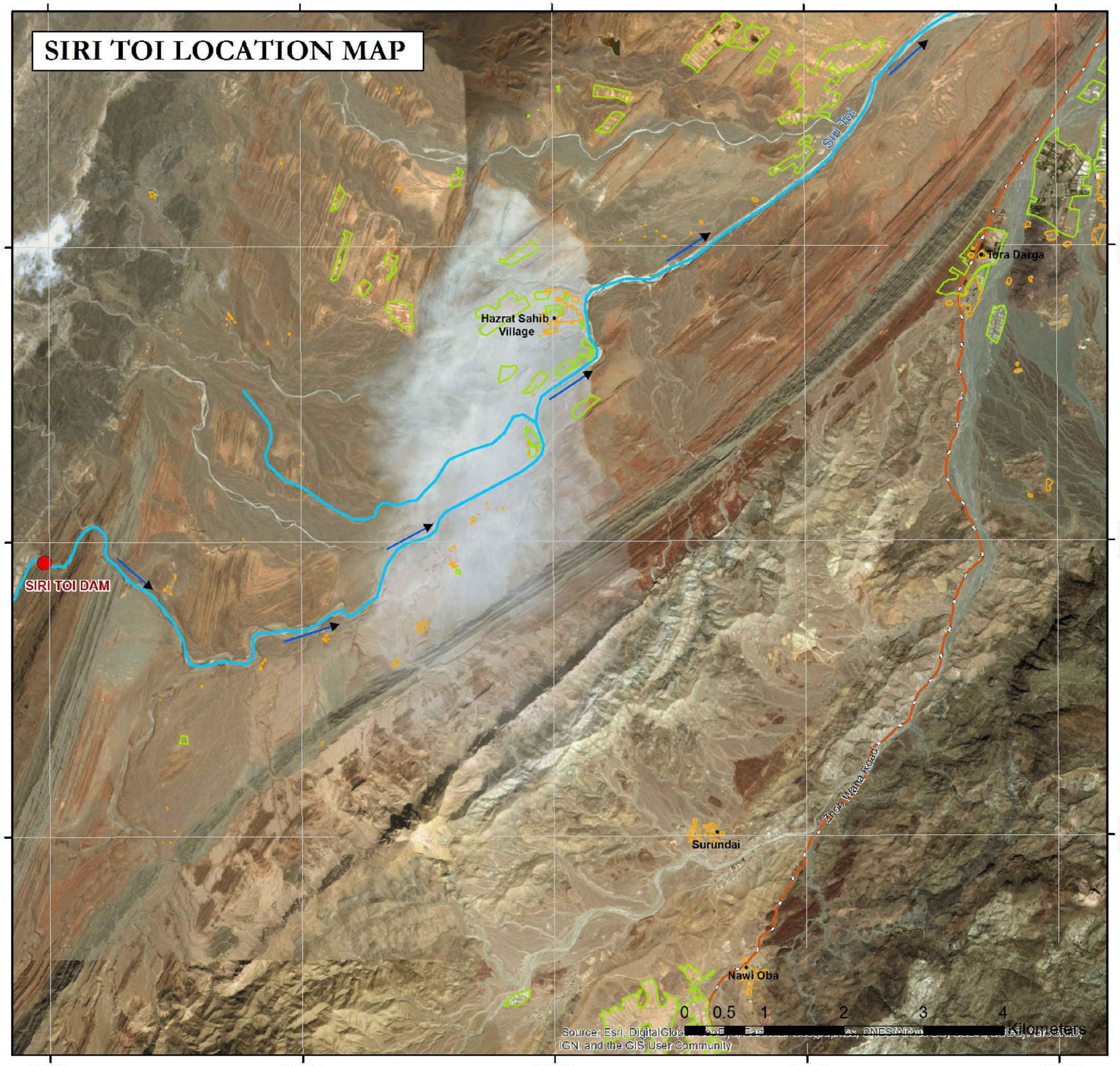
5. Bars in columns shall be joggled for laps with starter bars.

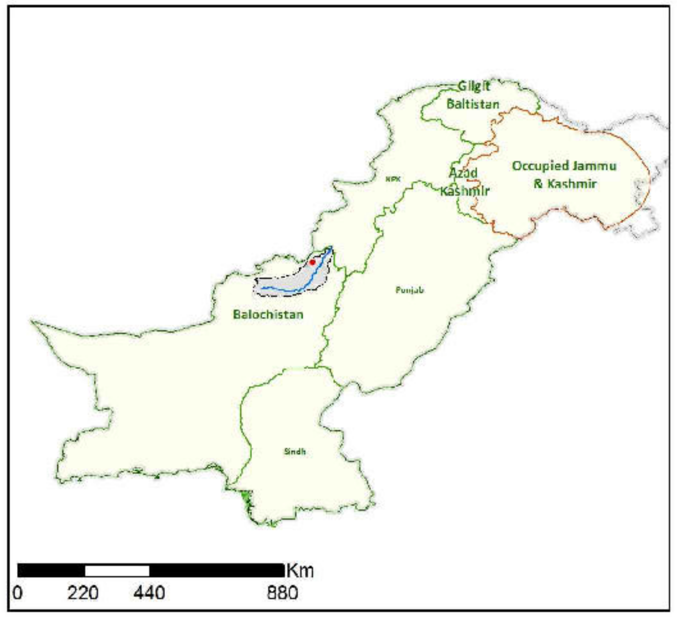
F. MISCELLANEOUS

1. All waterstops shall be 230mm wide PVC waterstops with central bulb and of the shape and size shown on drawing.

2. Construction of Expansion, Contraction and Construction Joints in concrete lining or structure where shown on the drawings, shall be carried out as per requirements of technical specifications and drawings.

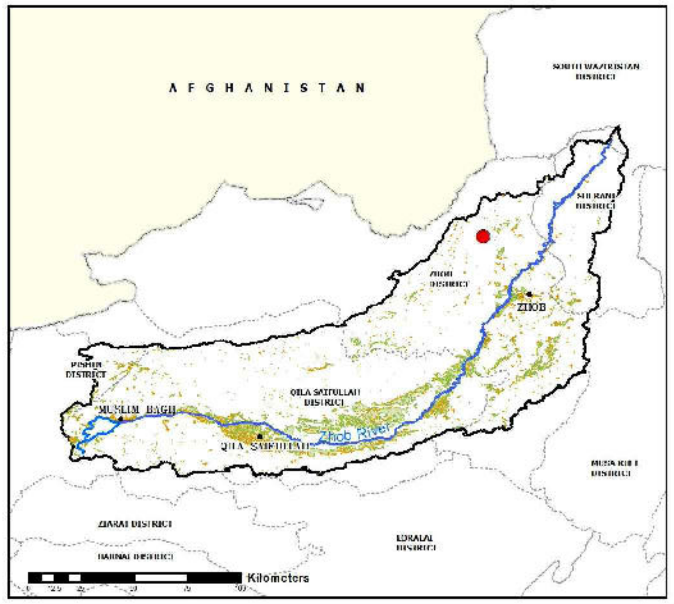
CLIENT : ADB ASIAN DEVELOPMENT BANK	CONSULTANT: Techno-Consult International (Pvt.)Ltd.	PROJECT: BALOCHISTAN WATER RESOURCES DEVELOPMENT PROJECT (TA)	DRAWING TITLE : GENERAL NOTES	Designed By : SAAD-UR-REHMAN	Date : NOVEMBER 2017	No. / Revision / By / Date
		SCHEME: SIRI TOI DAM ZHOB RIVER BASIN		Drawn By : ARSALAN RAFAT	Scale : -	
				Checked By : ZAFAR MASOOD SIDDIQUE	Drg No :	
				Approved By : DR BASHIR LAKHANI	BWRDP-MRB-KH-GD-002	





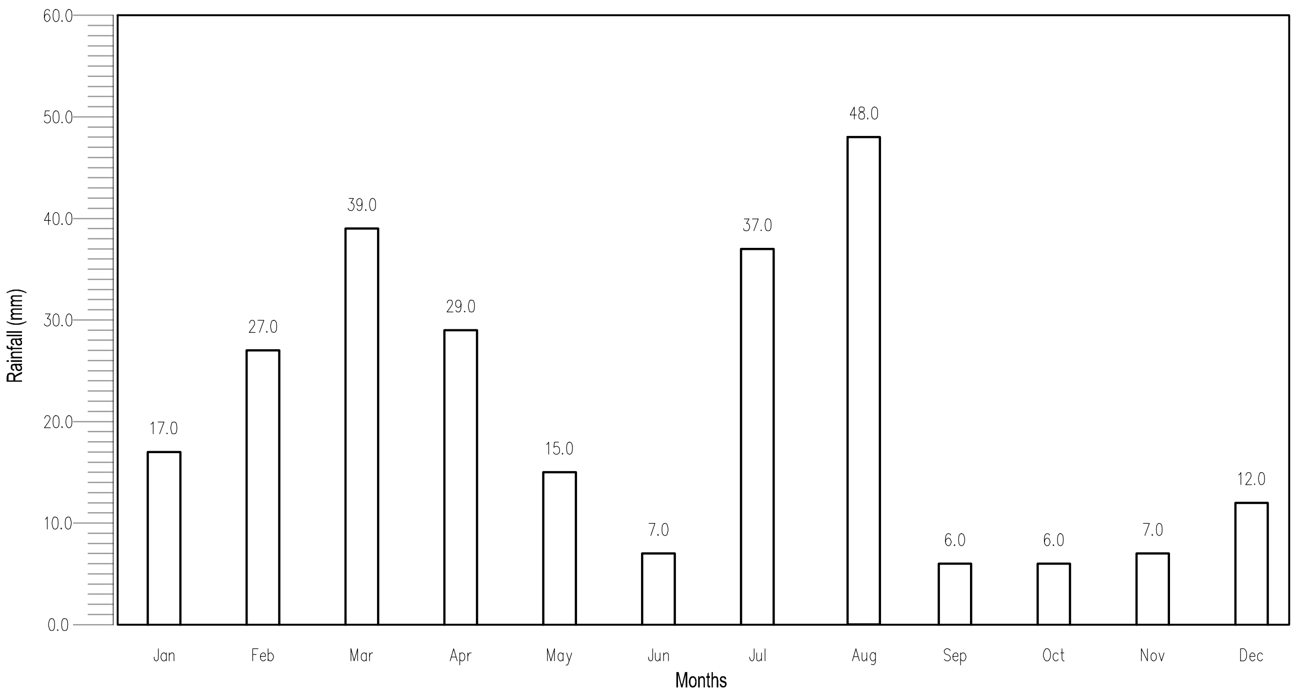
Legend
- Towns and Villages
- Scheme
- Roads
- Track
- Streams
- Zhob River
- Zhob River Basin
- Settlements
- Irrigated Land
- District Boundary
- International Boundary

ZHOB RIVER BASIN

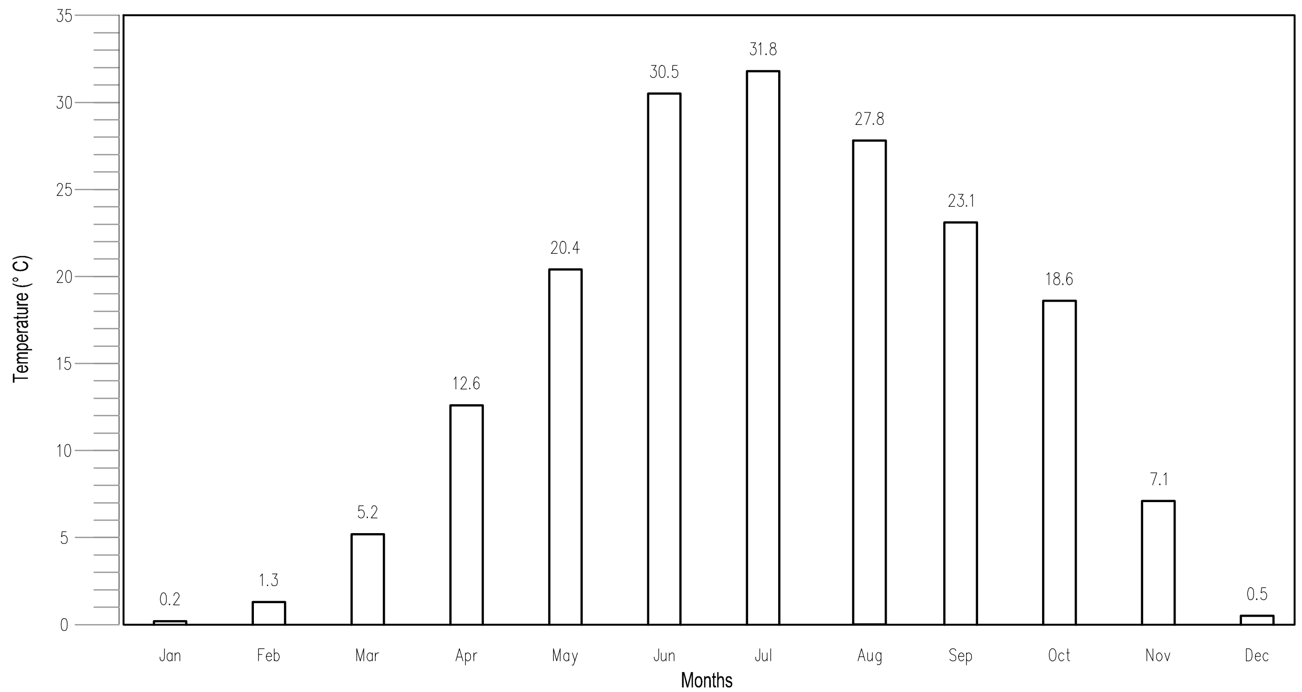


CLIENT: ASIAN DEVELOPMENT BANK	CONSULTANT: Techno-Consult International (Pvt.) Ltd.	PROJECT: BALOCHISTAN WATER RESOURCES DEVELOPMENT PROJECT (TA)	DRAWING TITLE:	Designed By: -	Date: NOVEMBER 2017
		SCHEME: SIRI TOI DAM ZHOB RIVER BASIN	PROJECT LOCATION MAP	Drawn By: -	Scale: AS SHOWN
				Checked By: ZAFAR MASOOD SIDDIQUE	Drg No:
				Approved By: DR BASHIR LAKHANI	BWRDP-ZRB-STD-GD-003

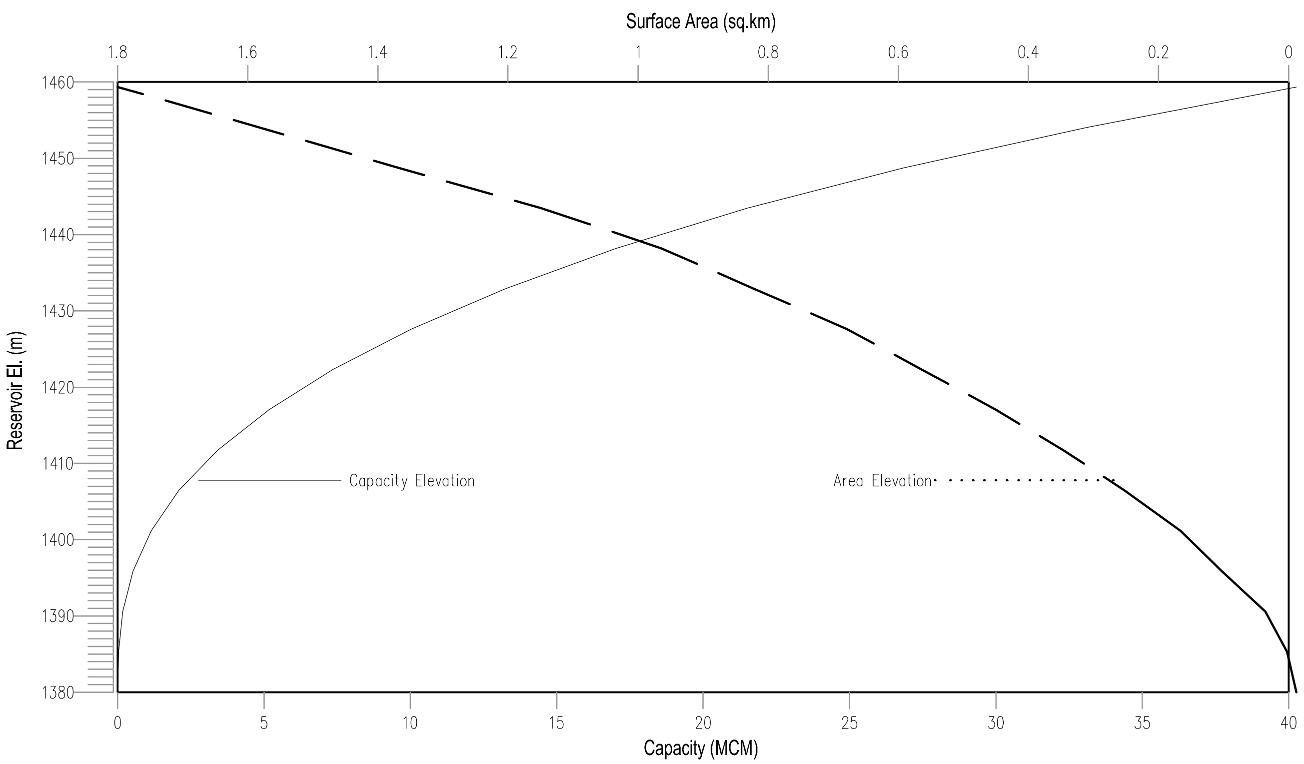
No.	Revision	By	Date



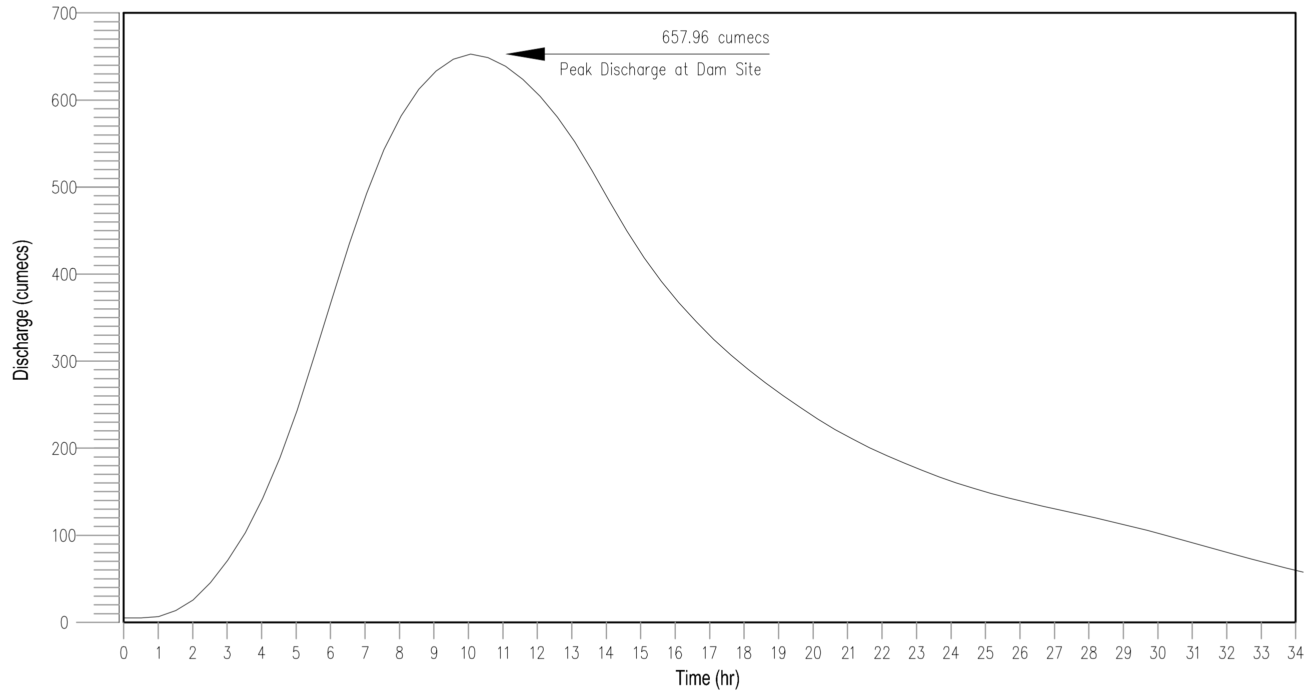
AVERAGE MONTHLY RAINFALL (1979-2015)



AVERAGE MONTHLY TEMPERATURE (1979-2015)



AREA-ELEVATION-CAPACITY (AEC) CURVE



25-YEAR RETURN PERIOD FLOOD HYDROGRAPH

CLIENT :
ASIAN DEVELOPMENT BANK

CONSULTANT :
Techno-Consult International (Pvt.)Ltd.

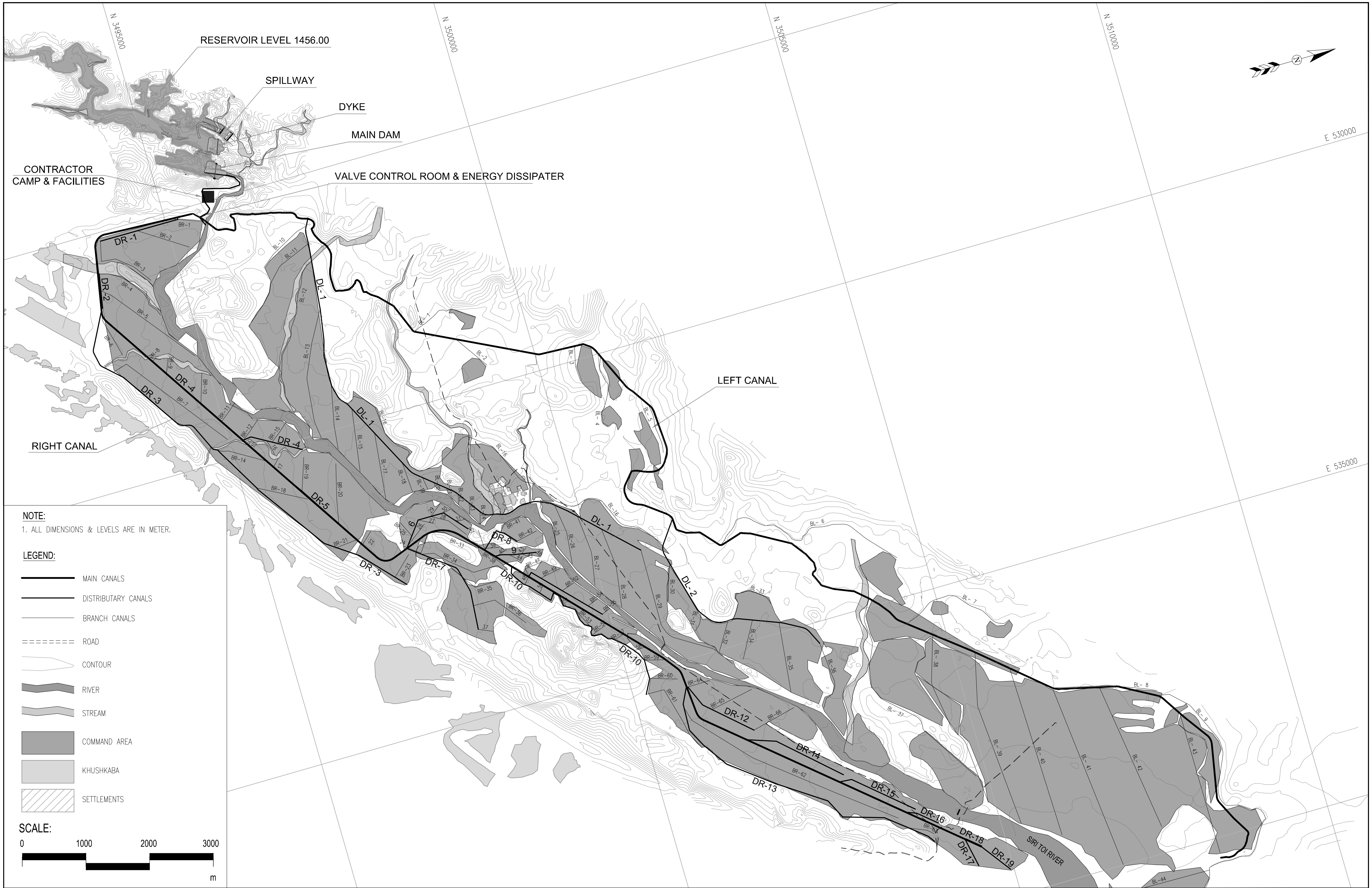
PROJECT:
BALOCHISTAN WATER RESOURCES DEVELOPMENT PROJECT (TA)

SCHEME:
SIRI TOI DAM
ZHOB RIVER BASIN

DRAWING TITLE :
AREA CAPACITY CURVE / CLIMATOLOGICAL DATA AND RUN OFF

Designed By :	ABDUL HAI	Date :	NOVEMBER 2017
Drawn By :	M. MAQSOOD	Scale :	-
Checked By :	ZAFAR MASOOD SIDDIQUE	Drg No :	
Approved By :	DR BASHIR LAKHANI		BWRDP-ZRB-STD-GD-004

No.	Revision	By	Date



NOTE:

1. ALL DIMENSIONS & LEVELS ARE IN METER.

LEGEND:

- MAIN CANALS
- DISTRIBUTARY CANALS
- BRANCH CANALS
- ROAD
- CONTOUR
- RIVER
- STREAM
- COMMAND AREA
- KHUSHKABA
- SETTLEMENTS

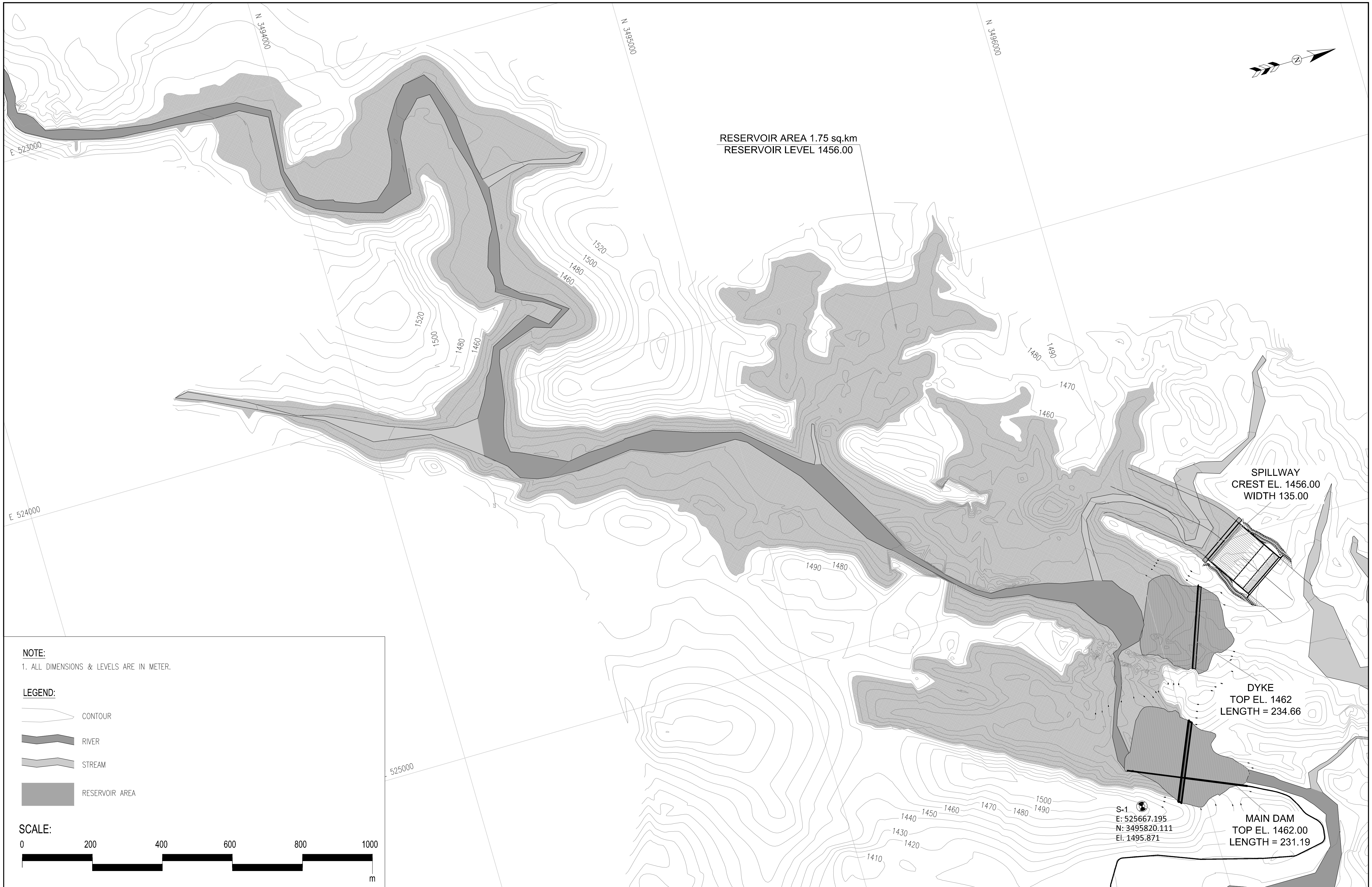
SCALE:

0 1000 2000 3000

m

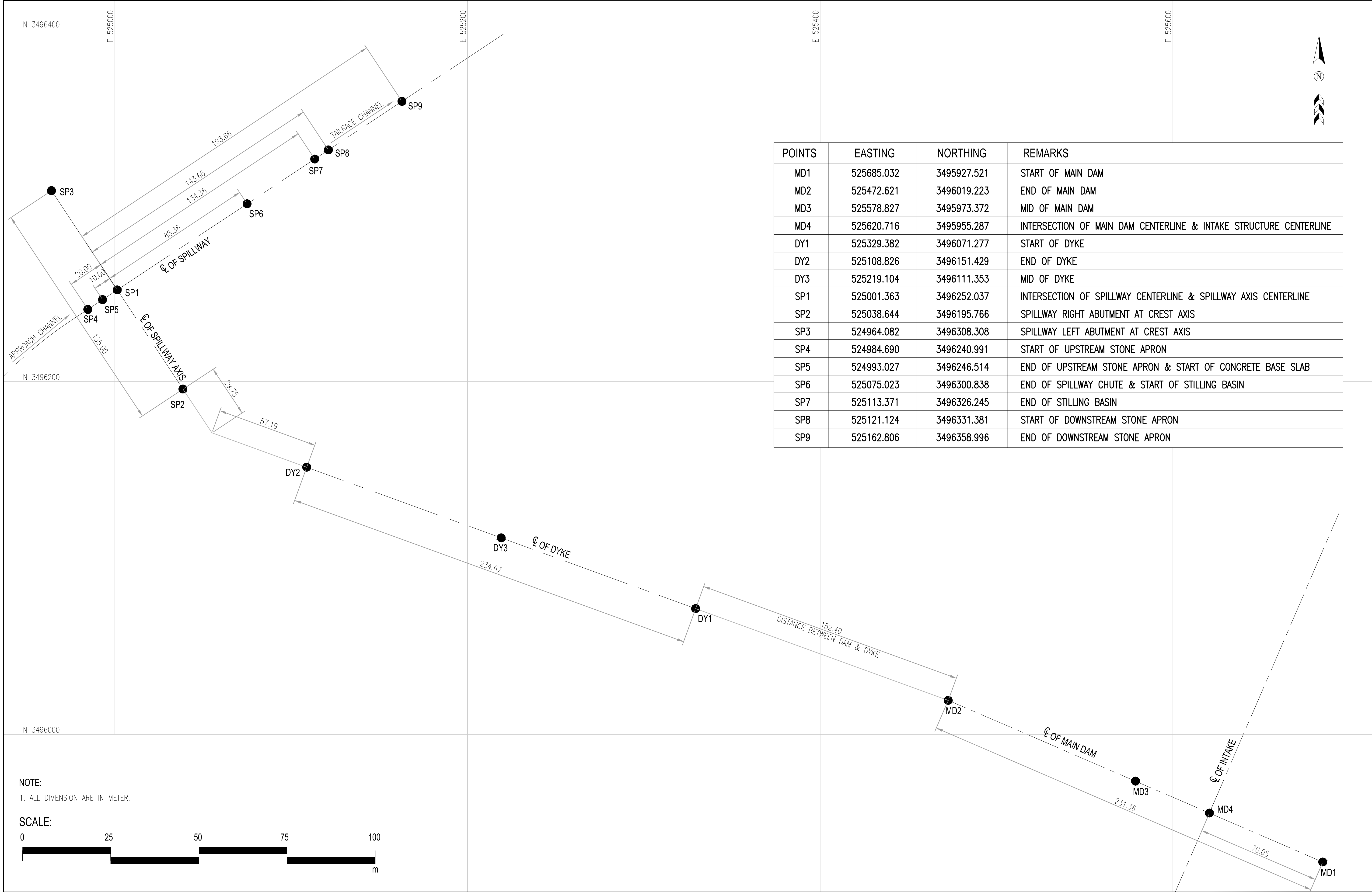
CLIENT : ADB ASIAN DEVELOPMENT BANK	CONSULTANT: Techno-Consult International (Pvt.)Ltd.	PROJECT: BALOCHISTAN WATER RESOURCES DEVELOPMENT PROJECT (TA) SCHEME: SIRI TOI DAM ZHOB RIVER BASIN	DRAWING TITLE : PROJECT LAYOUT PLAN	Designed By : SAAD / MEHROZ Drawn By : ARSALAN RAFAT Checked By : ZAFAR MASOOD SIDDIQUE Approved By : DR BASHIR LAKHANI	Date : NOVEMBER 2017 Scale : AS SHOWN Drg No : BWRDP-ZRB-STD-GD-005

No.	Revision	By	Date



CLIENT :	CONSULTANT :	PROJECT:	DRAWING TITLE :				
ADB ASIAN DEVELOPMENT BANK	Techno-Consult International (Pvt.)Ltd.	BALOCHISTAN WATER RESOURCES DEVELOPMENT PROJECT (TA)	RESERVOIR AREA LAYOUT PLAN	Designed By :	ABDUL HAI	Date :	NOVEMBER 2017
		SCHEME: SIRI TOI DAM ZHOB RIVER BASIN		Drawn By :	ARSALAN RAFAT	Scale :	AS SHOWN
				Checked By :	ZAFAR MASOOD SIDDIQUE	Drg No :	
				Approved By :	DR BASHIR LAKHANI		BWRDP-ZRB-STD-GD-006

No.	Revision	By	Date



POINTS	EASTING	NORTHING	REMARKS
MD1	525685.032	3495927.521	START OF MAIN DAM
MD2	525472.621	3496019.223	END OF MAIN DAM
MD3	525578.827	3495973.372	MID OF MAIN DAM
MD4	525620.716	3495955.287	INTERSECTION OF MAIN DAM CENTERLINE & INTAKE STRUCTURE CENTERLINE
DY1	525329.382	3496071.277	START OF DYKE
DY2	525108.826	3496151.429	END OF DYKE
DY3	525219.104	3496111.353	MID OF DYKE
SP1	525001.363	3496252.037	INTERSECTION OF SPILLWAY CENTERLINE & SPILLWAY AXIS CENTERLINE
SP2	525038.644	3496195.766	SPILLWAY RIGHT ABUTMENT AT CREST AXIS
SP3	524964.082	3496308.308	SPILLWAY LEFT ABUTMENT AT CREST AXIS
SP4	524984.690	3496240.991	START OF UPSTREAM STONE APRON
SP5	524993.027	3496246.514	END OF UPSTREAM STONE APRON & START OF CONCRETE BASE SLAB
SP6	525075.023	3496300.838	END OF SPILLWAY CHUTE & START OF STILLING BASIN
SP7	525113.371	3496326.245	END OF STILLING BASIN
SP8	525121.124	3496331.381	START OF DOWNSTREAM STONE APRON
SP9	525162.806	3496358.996	END OF DOWNSTREAM STONE APRON

NOTE:

1. ALL DIMENSION ARE IN METER.

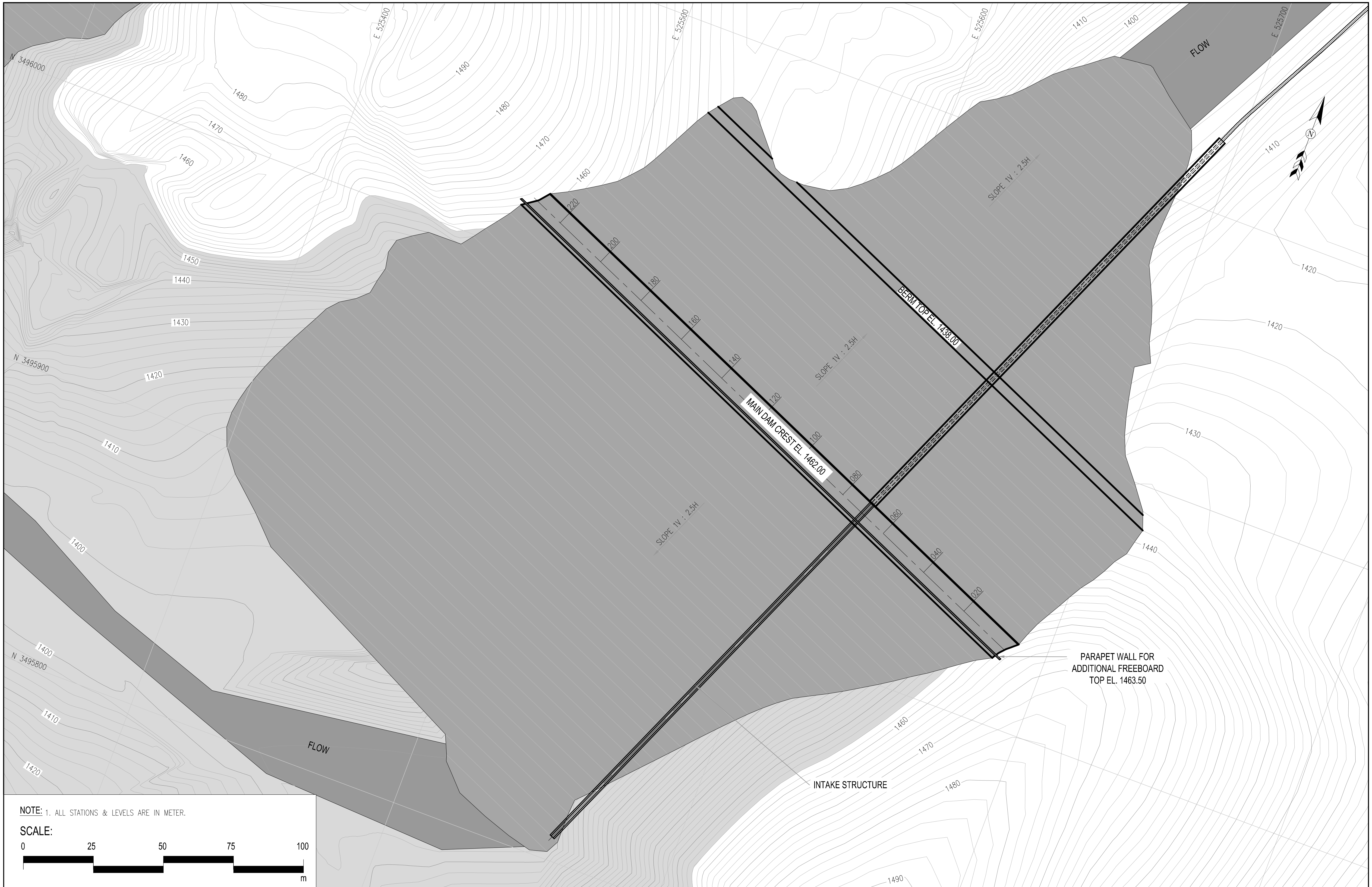
SCALE:

0 25 50 75 100 m

CLIENT :	CONSULTANT :	PROJECT:	DRAWING TITLE :				
ADB ASIAN DEVELOPMENT BANK	Techno-Consult International (Pvt.)Ltd.	BALOCHISTAN WATER RESOURCES DEVELOPMENT PROJECT (TA)	SETTINGOUT DATA	Designed By : ABDUL HAI	Date : NOVEMBER 2017	No.	Revision	By	Date
		SCHEME: SIRI TOI DAM ZHOB RIVER BASIN		Drawn By : ARSALAN RAFAT	Scale : AS SHOWN				
				Checked By : ZAFAR MASOOD SIDDIQUE	Drg No :				
				Approved By : DR BASHIR LAKHANI	BWRDP-ZRB-STD-GD-007				

SIRI TOI DAM

MAIN DAM



NOTE: 1. ALL STATIONS & LEVELS ARE IN METER.

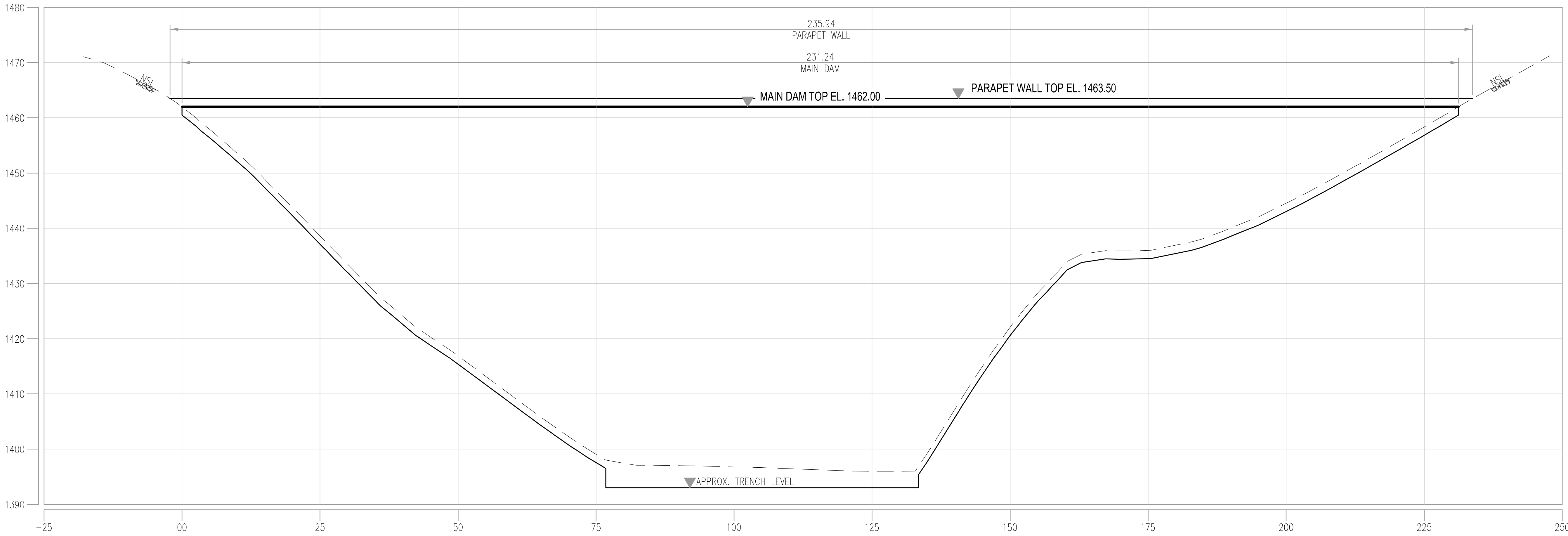
SCALE:

0 25 50 75 100 m

CLIENT : ADB ASIAN DEVELOPMENT BANK	CONSULTANT : Techno-Consult International (Pvt.)Ltd.	PROJECT: BALOCHISTAN WATER RESOURCES DEVELOPMENT PROJECT (TA)	DRAWING TITLE : MAIN DAM LAYOUT PLAN	Designed By : ABDUL HAI	Date : NOVEMBER 2017
		SCHEME: SIRI TOI DAM ZHOB RIVER BASIN		Drawn By : ARSALAN RAFAT	Scale : AS SHOWN
				Checked By : ZAFAR MASOOD SIDDIQUE	Drg No :
				Approved By : DR BASHIR LAKHANI	BWRDP-ZRB-STD-MD-101

No.	Revision	By	Date

NOTE:
1. ALL DIMENSIONS & LEVELS ARE IN METER.

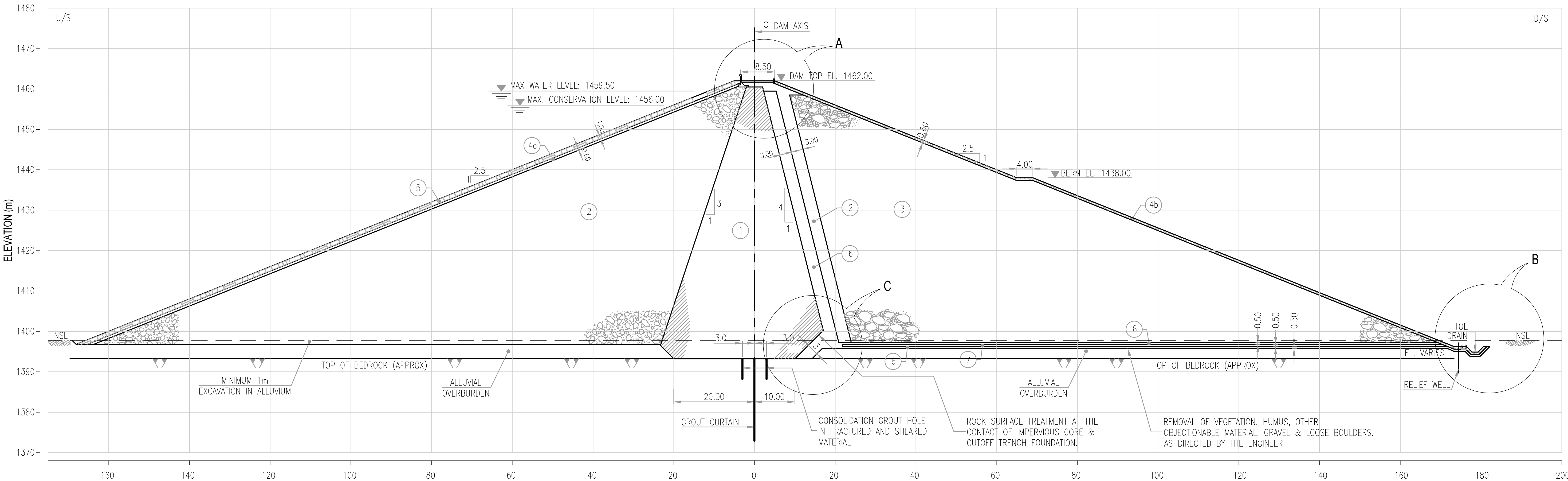


LONGITUDINAL SECTION

SCALE:
0 25 50
m

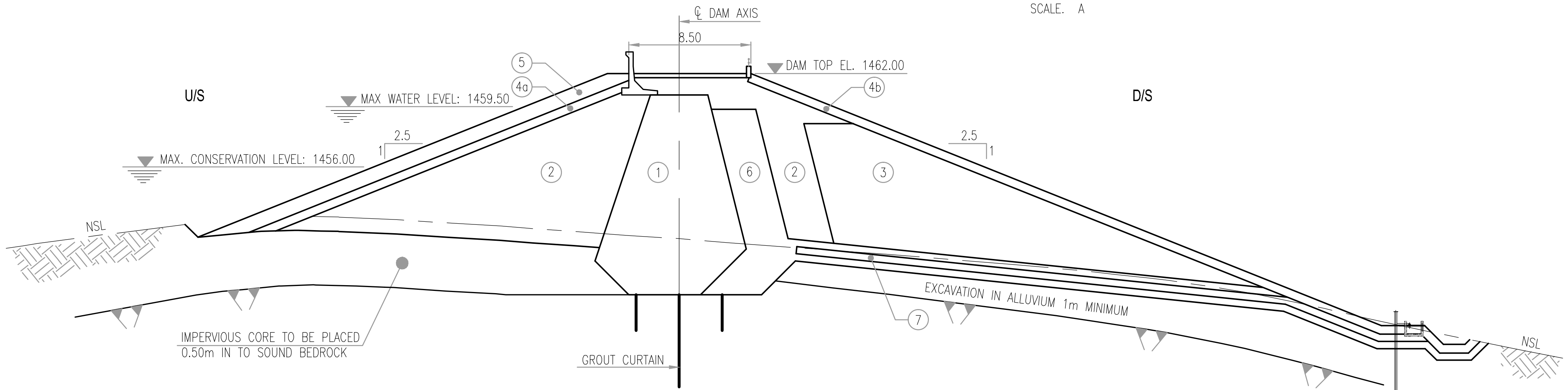
CLIENT : ASIAN DEVELOPMENT BANK	CONSULTANT: Techno-Consult International (Pvt.)Ltd.	PROJECT: BALOCHISTAN WATER RESOURCES DEVELOPMENT PROJECT (TA)	DRAWING TITLE : MAIN DAM LONGITUDINAL SECTION	
		SCHEME: SIRI TOI DAM ZHOB RIVER BASIN		
Designed By :	ABDUL HAI	Date :	NOVEMBER 2017	
Drawn By :	ARSALAN RAFAT	Scale :	AS SHOWN	
Checked By :	ZAFAR MASOOD SIDDIQUE	Drg No :		
Approved By :	DR BASHIR LAKHANI		BWRDP-ZRB-STD-MD-102	

No.	Revision	By	Date



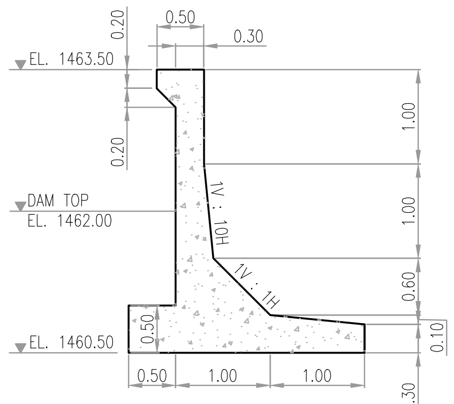
MAXIMUM SECTION THROUGH RIVER BED

SCALE. A



TYPICAL ABUTMENT DETAIL

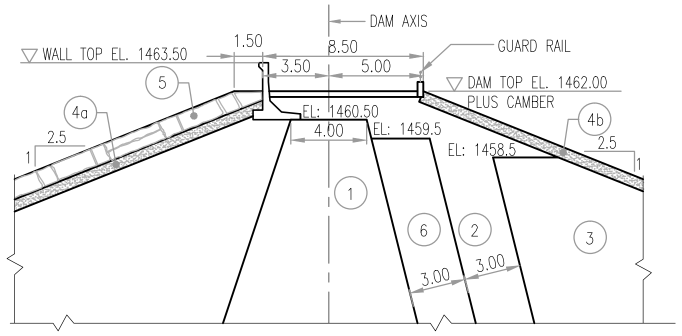
SCALE: B



PARAPET WALL FOR ADDITIONAL FREEBOARD

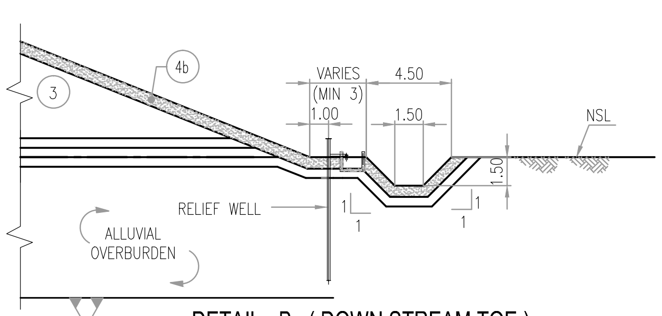
N.T.S

ZONE	MATERIAL
1	IMPERVIOUS CORE
2	SANDY GRAVEL
3	RANDOM FILL
4a	RIPRAP BEDDING
4b	D/S SLOPE PROTECTION
5	RIPRAP
6	SAND FILTER
7	DRAINAGE BLANKET



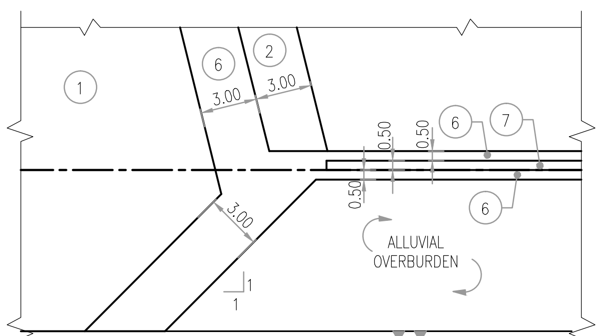
DETAIL - A (DAM CREST)

SCALE: B



DETAIL - B (DOWN STREAM TOE)

SCALE. B



DETAIL - C (FILTER)

SCALE. B

NOTES :

1. ALL DIMENSIONS AND LEVELS ARE IN METERS.
2. CUTOFF TRENCH TO BE EXTENDED DOWN TO THE TOP OF BEDROCK,INCASE OF DEEP ALLUVIAL OVERBURDEN SHEET PILING, CEMENT BOUND CURTAIN CUTOFF OR SLURRY TRENCH WILL BE PROVIDED AFTER ENGINEER'S APPROVAL

SCALE A: 0 10 20 30 40 m

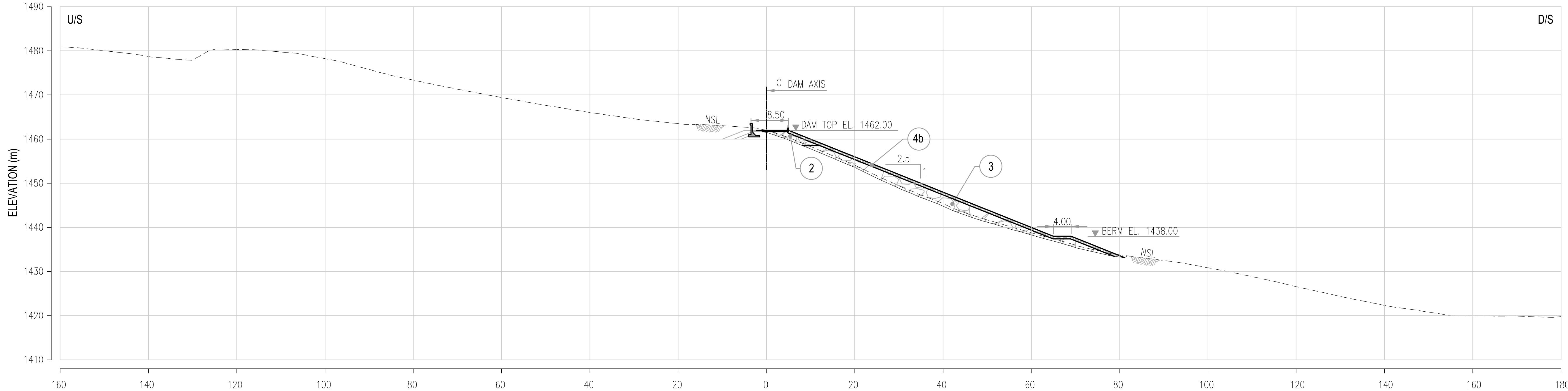
SCALE B: 0 5 10 15 m

CLIENT :	CONSULTANT:	PROJECT:	DRAWING TITLE :				
ADB ASIAN DEVELOPMENT BANK	Techno-Consult International (Pvt.)Ltd.	BALOCHISTAN WATER RESOURCES DEVELOPMENT PROJECT (TA)	MAIN DAM TYPICAL CROSS SECTION	Designed By :	ABDUL HAI	Date :	NOVEMBER 2017
		SCHEME: SIRI TOI DAM ZHOB RIVER BASIN		Drawn By :	ARSALAN RAFAT	Scale :	AS SHOWN
				Checked By :	ZAFAR MASOOD SIDDIQUE	Drg No :	BWRDP-ZRB-STD-MD-103
				Approved By :	DR BASHIR LAKHANI		

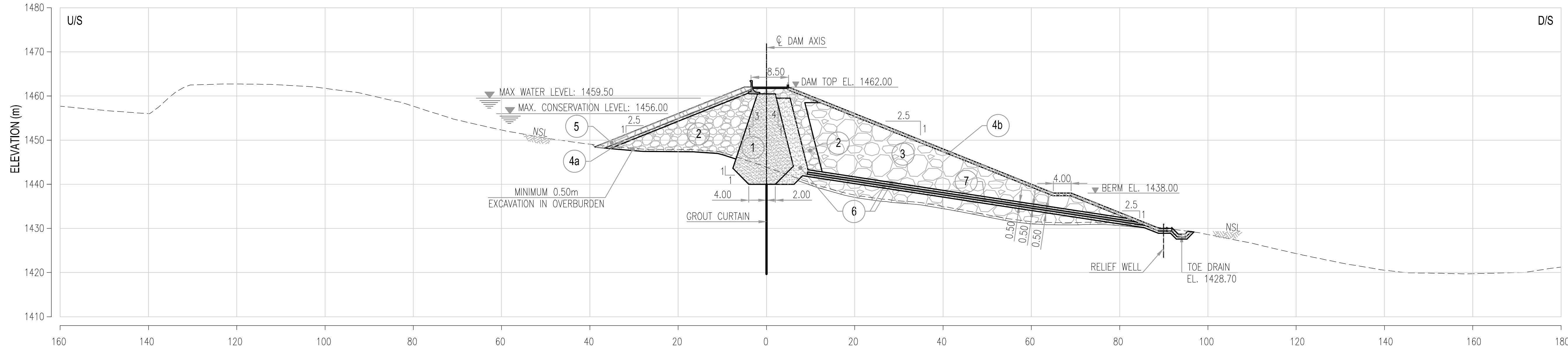
No.	Revision	By	Date

NOTES :

1. ALL DIMENSIONS, STATIONS AND LEVELS ARE IN METERS.
2. CUTOFF TRENCH TO BE EXTENDED DOWN TO THE TOP OF BEDROCK.



CROSS SECTION AT STATION 0+000



CROSS SECTION AT STATION 0+020

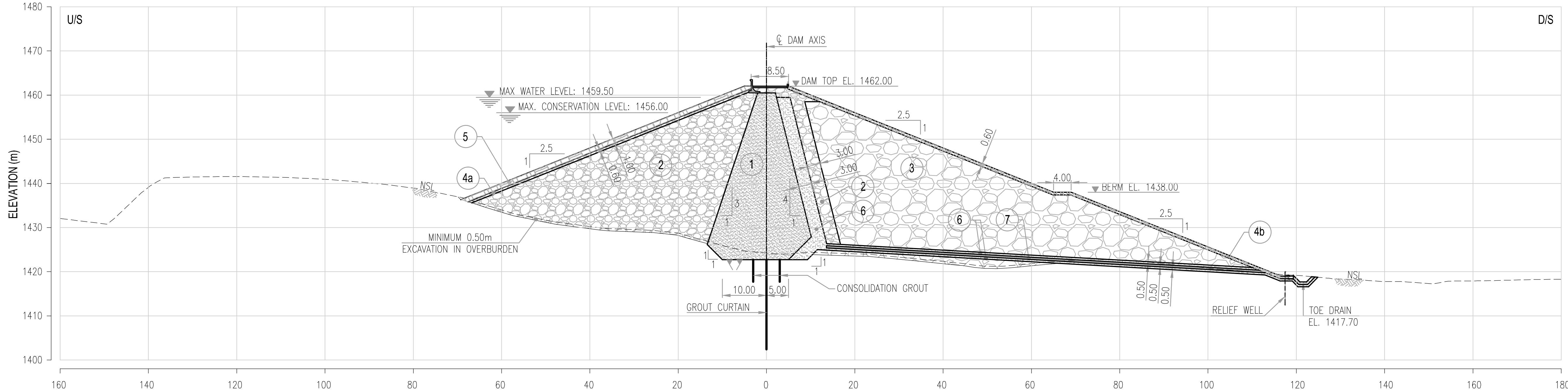
SCALE :
0 10 20 30 40 50
m

CLIENT : ADB ASIAN DEVELOPMENT BANK	CONSULTANT: Techno-Consult International (Pvt.)Ltd.	PROJECT: BALOCHISTAN WATER RESOURCES DEVELOPMENT PROJECT (TA)	DRAWING TITLE : MAIN DAM CROSS SECTIONS AT STATION 0+000 & 0+020	Designed By : ABDUL HAI	Date : NOVEMBER 2017
		SCHEME: SIRI TOI DAM ZHOB RIVER BASIN		Drawn By : ARSALAN RAFAT	Scale : AS SHOWN
				Checked By : ZAFAR MASOOD SIDDIQUE	Drg No :
				Approved By : DR BASHIR LAKHANI	BWRDP-ZRB-STD-MD-151

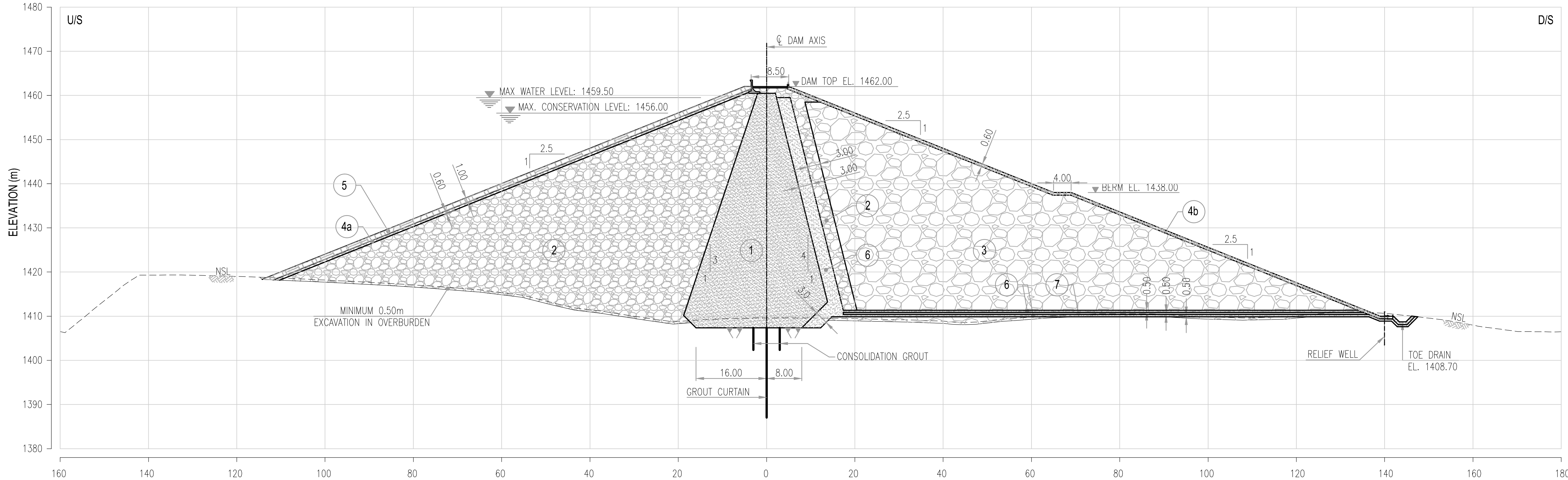
No.	Revision	By	Date

NOTES :

1. ALL DIMENSIONS, STATIONS AND LEVELS ARE IN METERS.
2. CUTOFF TRENCH TO BE EXTENDED DOWN TO THE TOP OF BEDROCK.



CROSS SECTION AT STATION 0+040



CROSS SECTION AT STATION 0+060

SCALE :
0 10 20 30 40 50
m

CLIENT : ASIAN DEVELOPMENT BANK

CONSULTANT: Techno-Consult International (Pvt.)Ltd.

PROJECT: BALOCHISTAN WATER RESOURCES DEVELOPMENT PROJECT (TA)

SCHEME: SIRI TOI DAM ZHOB RIVER BASIN

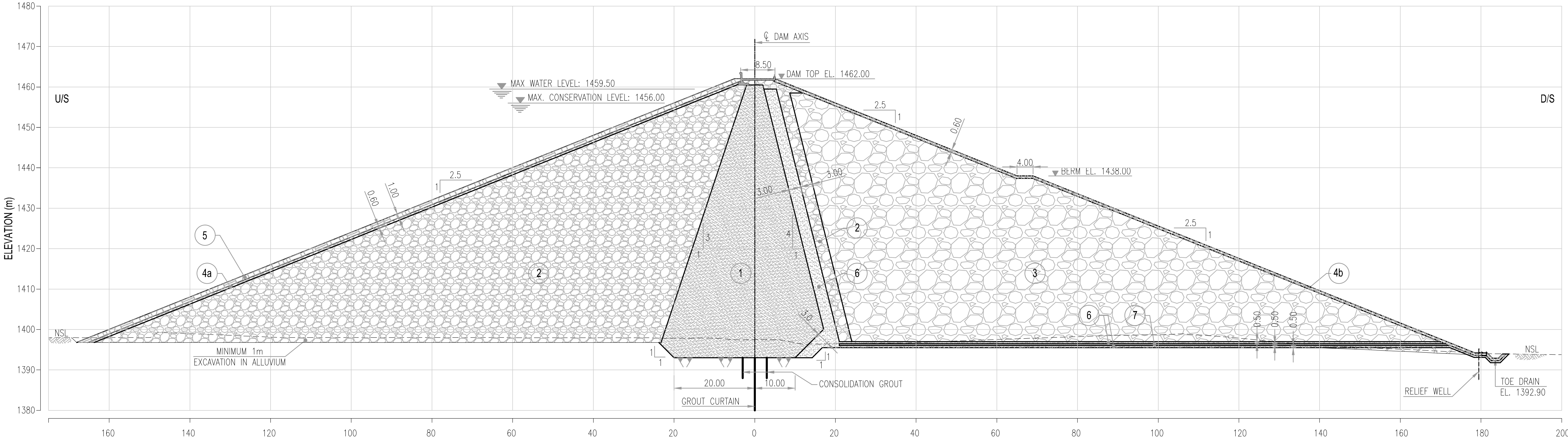
DRAWING TITLE : MAIN DAM CROSS SECTIONS AT STATION 0+040 & 0+060

Designed By :	ABDUL HAI	Date :	NOVEMBER 2017
Drawn By :	ARSALAN RAFAT	Scale :	AS SHOWN
Checked By :	ZAFAR MASOOD SIDDIQUE	Drg No :	
Approved By :	DR BASHIR LAKHANI		BWRDP-ZRB-STD-MD-152

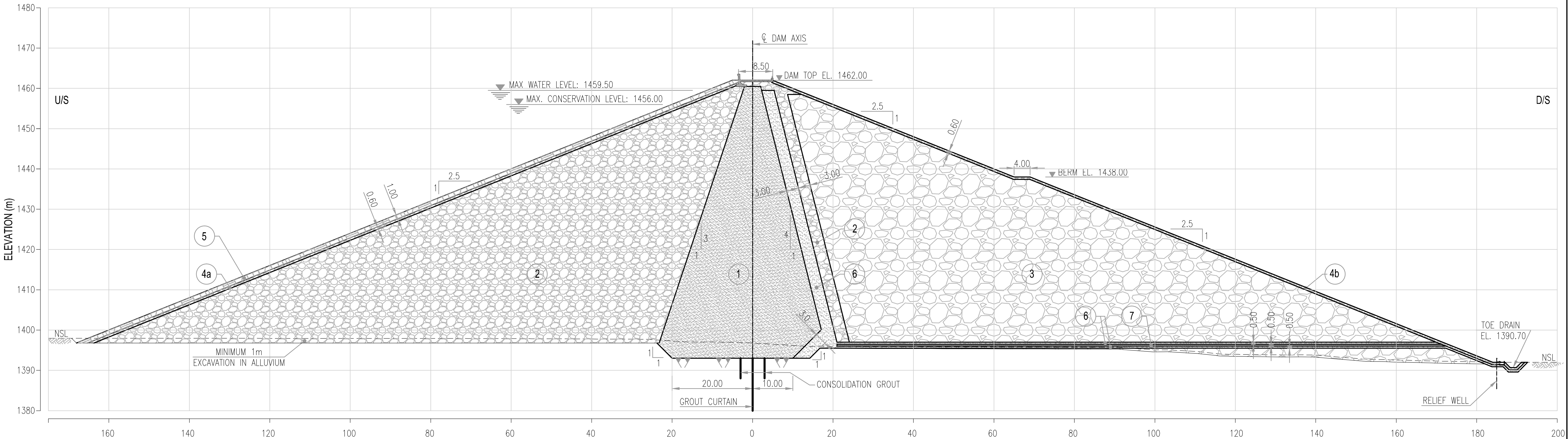
No.	Revision	By	Date

NOTES :

1. ALL DIMENSIONS, STATIONS AND LEVELS ARE IN METERS.
2. CUTOFF TRENCH TO BE EXTENDED DOWN TO THE TOP OF BEDROCK.



CROSS SECTION AT STATION 0+080



CROSS SECTION AT STATION 0+100

SCALE : 0 10 20 30 40 50 m

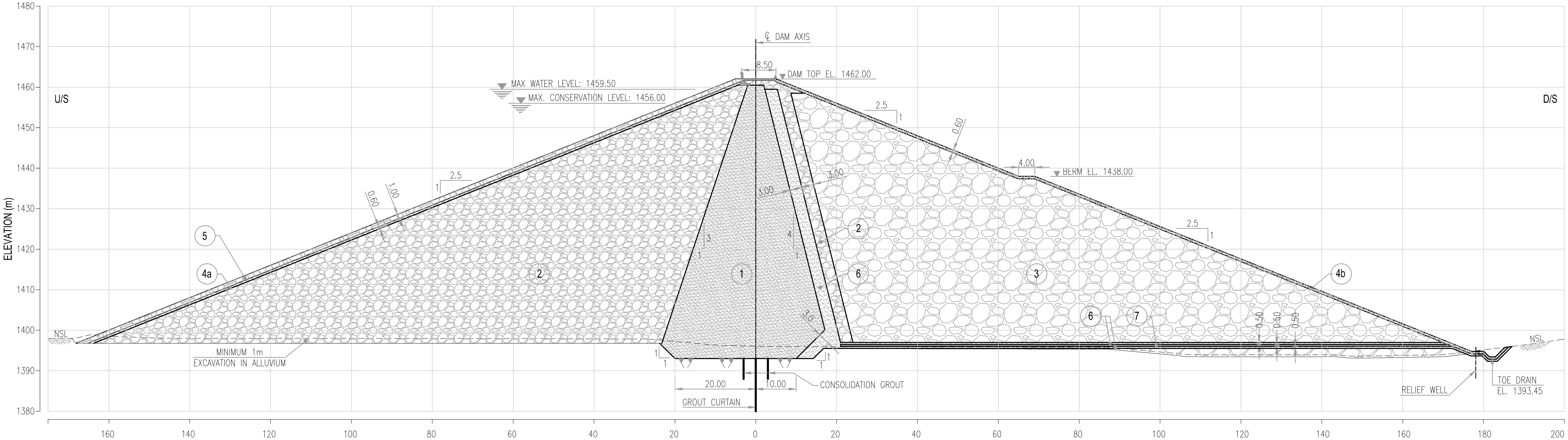
CLIENT : ADB ASIAN DEVELOPMENT BANK	CONSULTANT: Techno-Consult International (Pvt.)Ltd.	PROJECT: BALOCHISTAN WATER RESOURCES DEVELOPMENT PROJECT (TA)	DRAWING TITLE : MAIN DAM CROSS SECTIONS AT STATION 0+080 & 0+100	
		SCHEME: SIRI TOI DAM ZHOB RIVER BASIN		

Designed By :	ABDUL HAI	Date :	NOVEMBER 2017
Drawn By :	ARSALAN RAFAT	Scale :	AS SHOWN
Checked By :	ZAFAR MASOOD SIDDIQUE	Drg No :	
Approved By :	DR BASHIR LAKHANI		BWRDP-ZRB-STD-MD-153

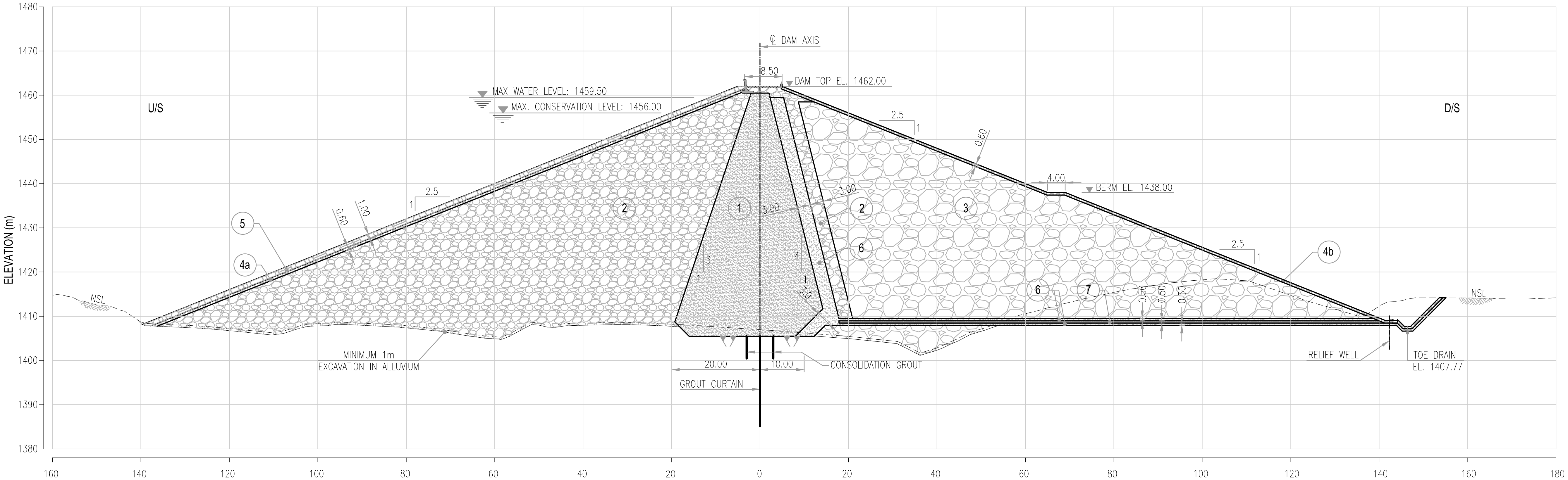
No.	Revision	By	Date

NOTES :

1. ALL DIMENSIONS, STATIONS AND LEVELS ARE IN METERS.
2. CUTOFF TRENCH TO BE EXTENDED DOWN TO THE TOP OF BEDROCK.



CROSS SECTION AT STATION 0+120



CROSS SECTION AT STATION 0+140

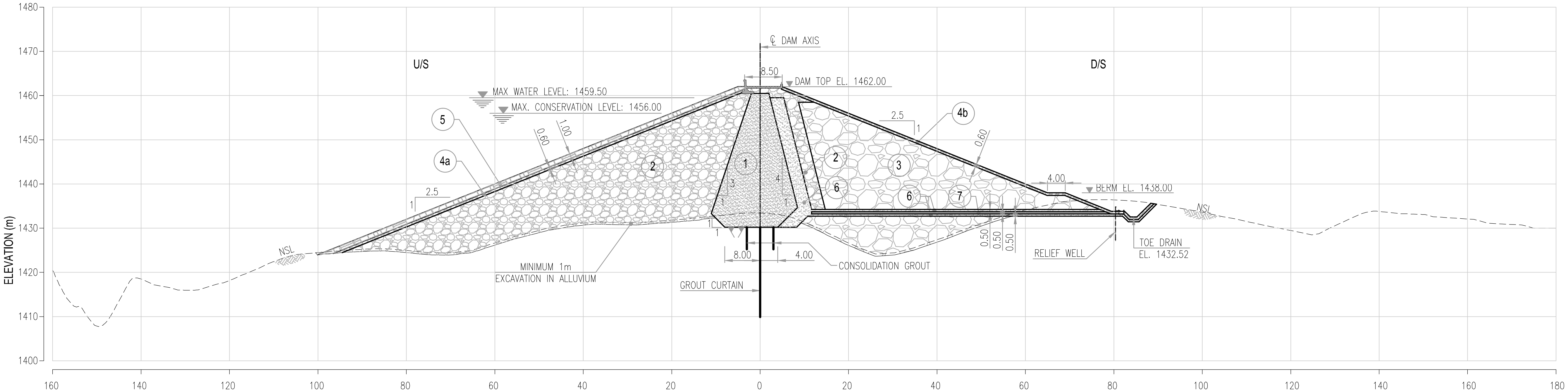
SCALE :
0 10 20 30 40 50
m

CLIENT :	CONSULTANT:	PROJECT:	DRAWING TITLE :				
ASIAN DEVELOPMENT BANK	Techno-Consult International (Pvt.)Ltd.	BALOCHISTAN WATER RESOURCES DEVELOPMENT PROJECT (TA)	MAIN DAM CROSS SECTIONS AT STATION 0+120 & 0+140	Designed By : ABDUL HAI	Date : NOVEMBER 2017		
		SCHEME: SIRI TOI DAM ZHOB RIVER BASIN		Drawn By : ARSALAN RAFAT	Scale : AS SHOWN		
				Checked By : ZAFAR MASOOD SIDDIQUE	Drg No :		
				Approved By : DR BASHIR LAKHANI	BWRDP-ZRB-STD-MD-154		

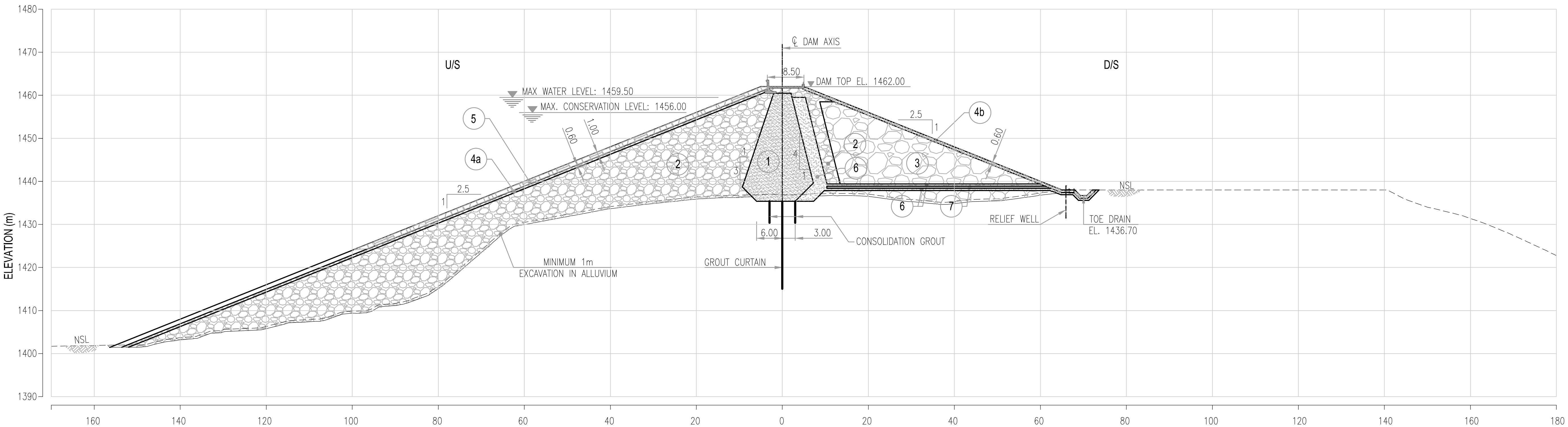
No.	Revision	By	Date

NOTES :

1. ALL DIMENSIONS, STATIONS AND LEVELS ARE IN METERS.
2. CUTOFF TRENCH TO BE EXTENDED DOWN TO THE TOP OF BEDROCK.



CROSS SECTION AT STATION 0+160



CROSS SECTION AT STATION 0+180

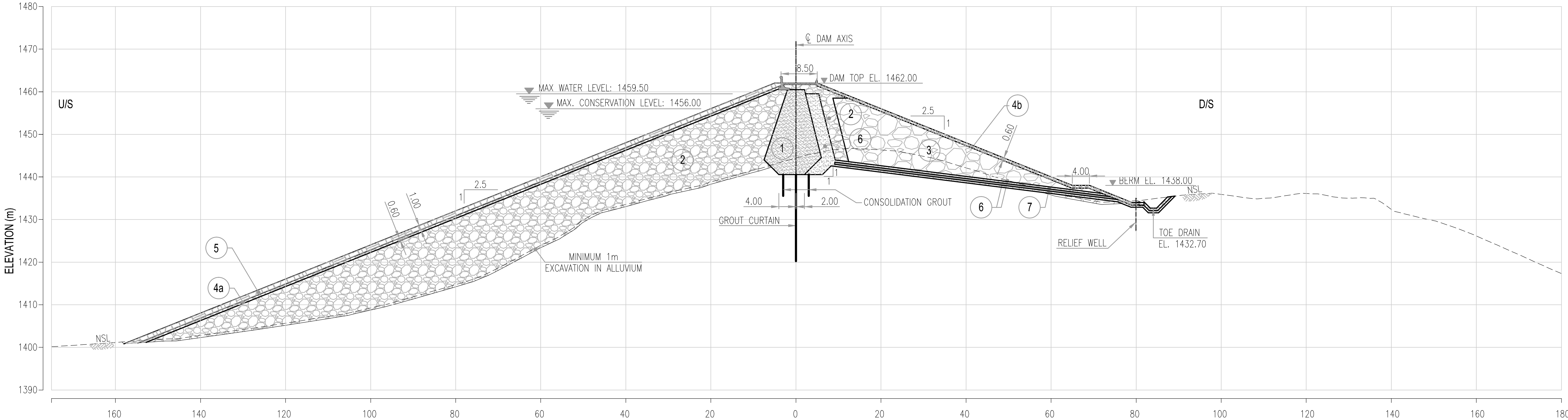
SCALE :
0 10 20 30 40 50
m

CLIENT :	CONSULTANT:	PROJECT:	DRAWING TITLE :				
ADB ASIAN DEVELOPMENT BANK	Techno-Consult International (Pvt.)Ltd.	BALOCHISTAN WATER RESOURCES DEVELOPMENT PROJECT (TA)	MAIN DAM CROSS SECTIONS AT STATION 0+160 & 0+180	Designed By : ABDUL HAI	Date : NOVEMBER 2017		
		SCHEME: SIRI TOI DAM ZHOB RIVER BASIN		Drawn By : ARSALAN RAFAT	Scale : AS SHOWN		
				Checked By : ZAFAR MASOOD SIDDIQUE	Drg No :		
				Approved By : DR BASHIR LAKHANI	BWRDP-ZRB-STD-MD-155		

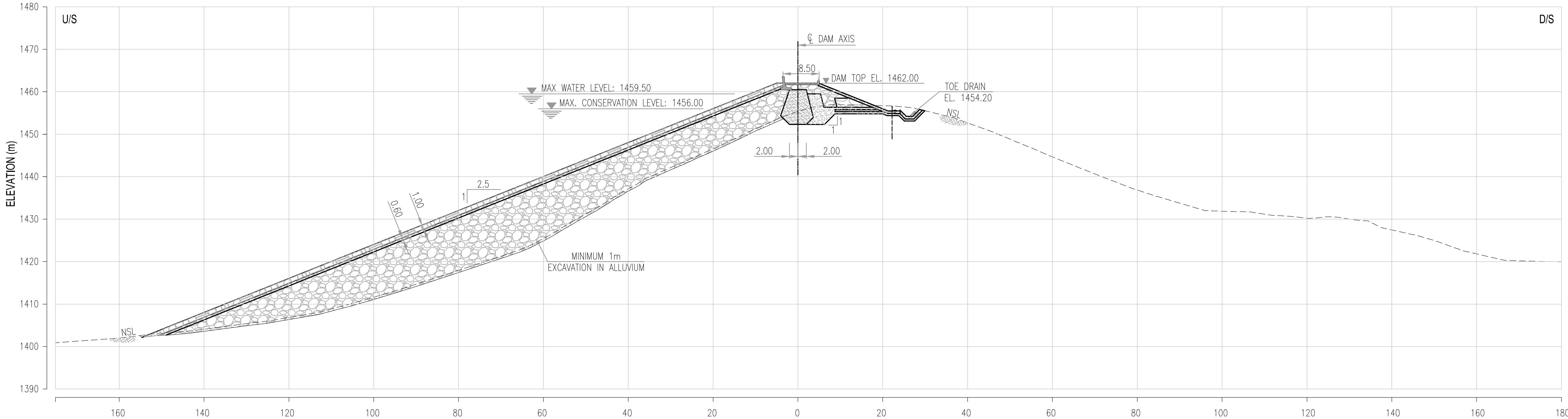
No.	Revision	By	Date

NOTES :

1. ALL DIMENSIONS, STATIONS AND LEVELS ARE IN METERS.
2. CUTOFF TRENCH TO BE EXTENDED DOWN TO THE TOP OF BEDROCK.



CROSS SECTION AT STATION 0+200



CROSS SECTION AT STATION 0+220

SCALE : 0 10 20 30 40 50 m

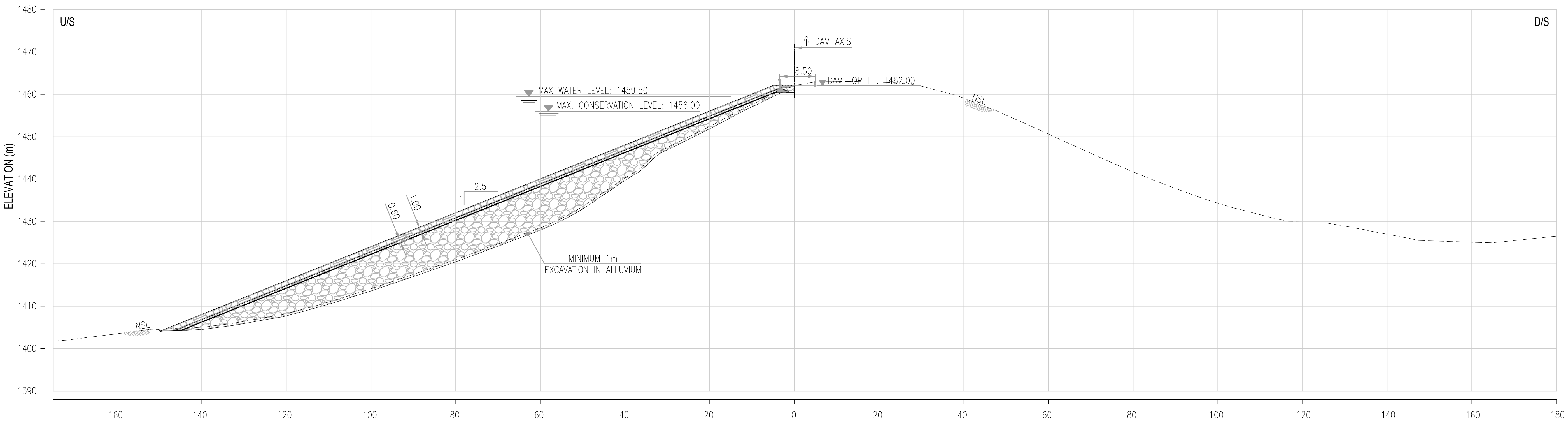
CLIENT : ADB ASIAN DEVELOPMENT BANK	CONSULTANT: Techno-Consult International (Pvt.)Ltd.	PROJECT: BALOCHISTAN WATER RESOURCES DEVELOPMENT PROJECT (TA)	DRAWING TITLE : MAIN DAM CROSS SECTIONS AT STATION 0+200 & 0+220	Designed By : ABDUL HAI
		SCHEME: SIRI TOI DAM ZHOB RIVER BASIN		Drawn By : ARSALAN RAFAT
				Checked By : ZAFAR MASOOD SIDDIQUE
				Approved By : DR BASHIR LAKHANI

Date :	NOVEMBER 2017
Scale :	AS SHOWN
Drg No :	BWRDP-ZRB-STD-MD-156

No.	Revision	By	Date

NOTES :

1. ALL DIMENSIONS, STATIONS AND LEVELS ARE IN METERS.
2. CUTOFF TRENCH TO BE EXTENDED DOWN TO THE TOP OF BEDROCK.



CROSS SECTION AT STATION 0+231.36

SCALE :
0 10 20 30 40 50
m

CLIENT : ASIAN DEVELOPMENT BANK	CONSULTANT: Techno-Consult International (Pvt.)Ltd.	PROJECT: BALOCHISTAN WATER RESOURCES DEVELOPMENT PROJECT (TA)	DRAWING TITLE : MAIN DAM CROSS SECTIONS AT STATION 0+231.36	Designed By : ABDUL HAI	Date : NOVEMBER 2017
		SCHEME: SIRI TOI DAM ZHOB RIVER BASIN		Drawn By : ARSALAN RAFAT	Scale : AS SHOWN
				Checked By : ZAFAR MASOOD SIDDIQUE	Drg No :
				Approved By : DR BASHIR LAKHANI	BWRDP-ZRB-STD-MD-157

No.	Revision	By	Date

SIRI TOI DAM

DYKE

NOTE: 1. ALL STATIONS & LEVELS ARE IN METER.

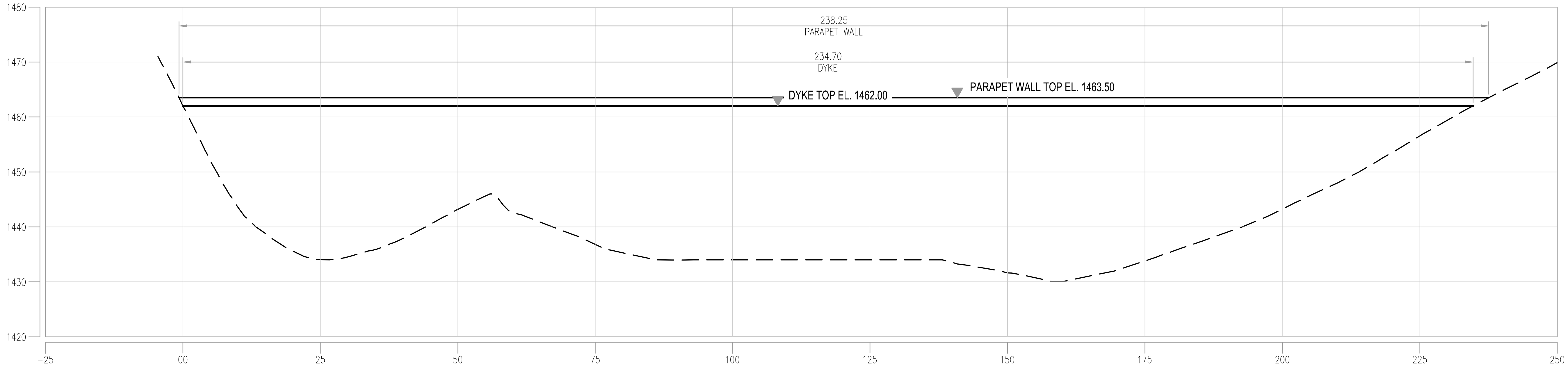
SCALE:

0 25 50 75 100 m

CLIENT : ASIAN DEVELOPMENT BANK	CONSULTANT : Techno-Consult International (Pvt.)Ltd.	PROJECT: BALOCHISTAN WATER RESOURCES DEVELOPMENT PROJECT (TA)	DRAWING TITLE : LAYOUT PLAN OF DYKE	Designed By : ABDUL HAI	Date : NOVEMBER 2017
		SCHEME: SIRI TOI DAM ZHOB RIVER BASIN		Drawn By : ARSALAN RAFAT	Scale : AS SHOWN
				Checked By : ZAFAR MASOOD SIDDIQUE	Drg No :
				Approved By : DR BASHIR LAKHANI	BWRDP-ZRB-STD-DY-201

No.	Revision	By	Date

NOTE:
1. ALL DIMENSIONS & LEVELS ARE IN METER.



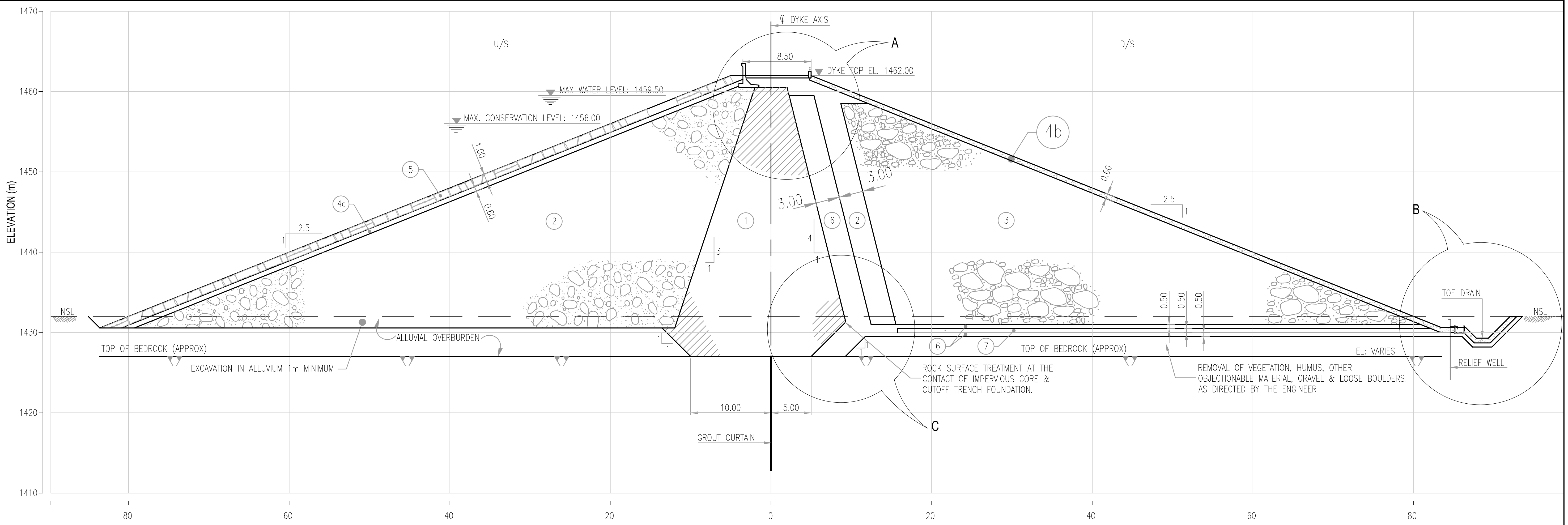
LONGITUDINAL SECTION

SCALE:
0 25 50
m

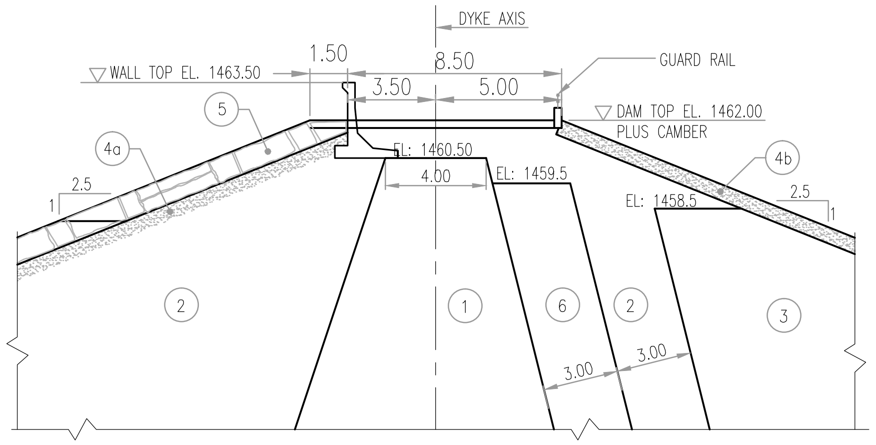
CLIENT : ASIAN DEVELOPMENT BANK	CONSULTANT: Techno-Consult International (Pvt.)Ltd.	PROJECT: BALOCHISTAN WATER RESOURCES DEVELOPMENT PROJECT (TA)	DRAWING TITLE : DYKE LONGITUDINAL SECTION	
		SCHEME: SIRI TOI DAM ZHOB RIVER BASIN		

Designed By :	ABDUL HAI	Date :	NOVEMBER 2017
Drawn By :	ARSALAN RAFAT	Scale :	AS SHOWN
Checked By :	ZAFAR MASOOD SIDDIQUE	Drg No :	
Approved By :	DR BASHIR LAKHANI		BWRDP-ZRB-STD-DY-202

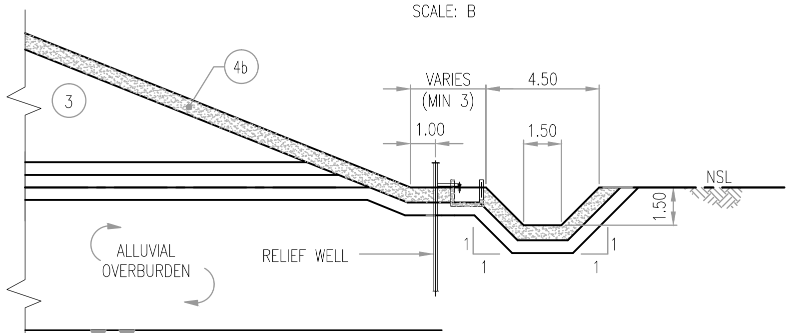
No.	Revision	By	Date



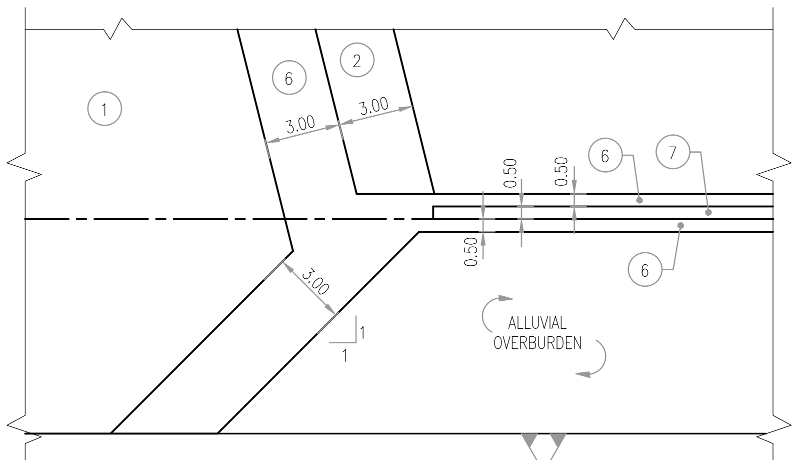
MAXIMUM CROSS SECTION
SCALE. A



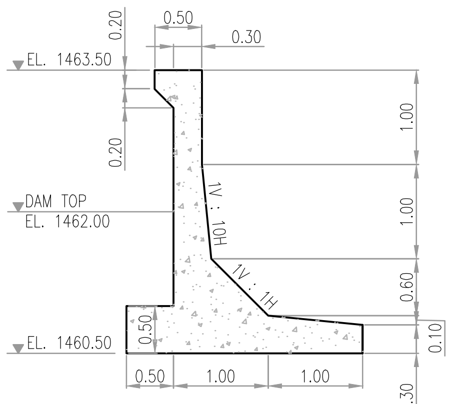
DETAIL - A (DYKE CREST)
SCALE: B



DETAIL - B (DOWN STREAM TOE)
SCALE. B



DETAIL - C (FILTER)
SCALE. B



PARAPET WALL FOR ADDITIONAL FREEBOARD
N.T.S

ZONE	MATERIAL
1	IMPERVIOUS CORE
2	SANDY GRAVEL
3	RANDOM FILL
4a	RIPRAP BEDDING
4b	D/S SLOPE PROTECTION
5	RIPRAP
6	SAND FILTER
7	DRAINAGE BLANKET

NOTES :
1. ALL DIMENSIONS AND LEVELS ARE IN METERS.

SCALE A: 0 5 10 15 20 m

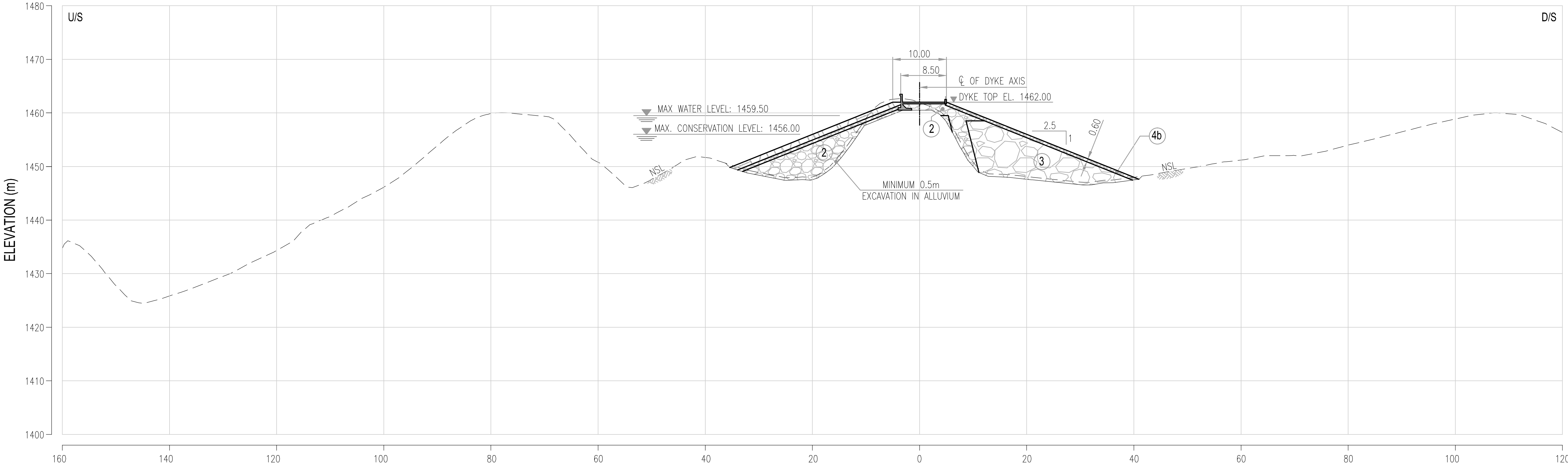
SCALE B: 0 5 10 15 m

CLIENT : ADB ASIAN DEVELOPMENT BANK	CONSULTANT: Techno-Consult International (Pvt.)Ltd.	PROJECT: BALOCHISTAN WATER RESOURCES DEVELOPMENT PROJECT (TA)	DRAWING TITLE : DYKE TYPICAL CROSS SECTION	Designed By : ABDUL HAI	Date : NOVEMBER 2017
		SCHEME: SIRI TOI DAM ZHOB RIVER BASIN		Drawn By : ARSALAN RAFAT	Scale : AS SHOWN
				Checked By : ZAFAR MASOOD SIDDIQUE	Drg No :
				Approved By : DR BASHIR LAKHANI	BWRDP-ZRB-STD-DY-203

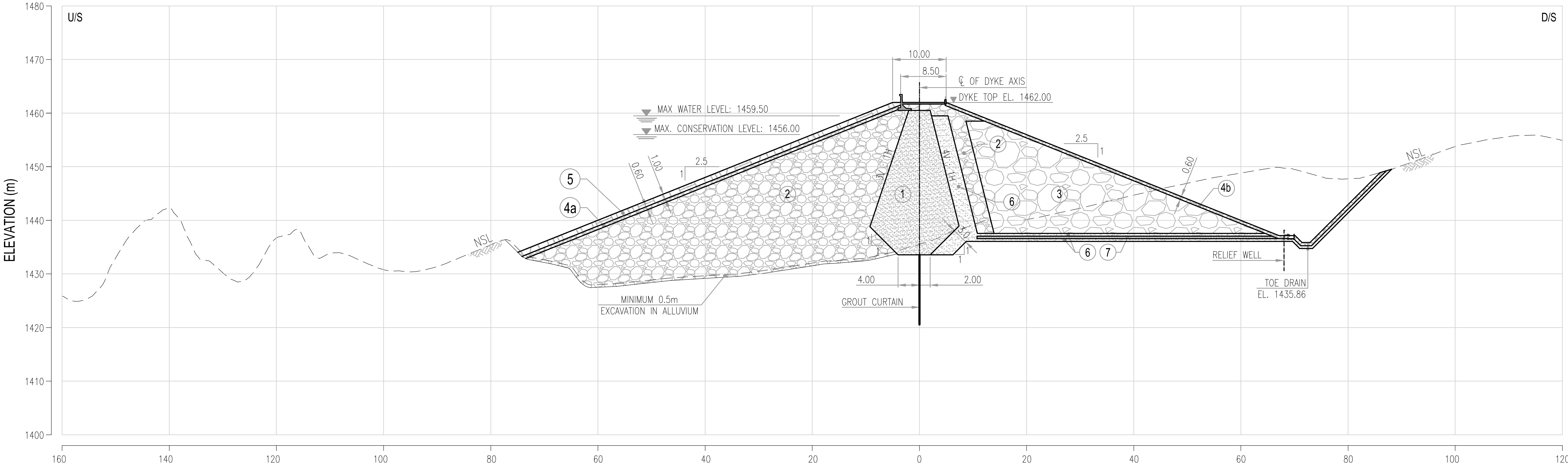
No.	Revision	By	Date

NOTES :

1. ALL DIMENSIONS, STATIONS AND LEVELS ARE IN METERS.
2. CUTOFF TRENCH TO BE EXTENDED DOWN TO THE TOP OF BEDROCK.



CROSS SECTION AT STATION 0+000



CROSS SECTION AT STATION 0+020

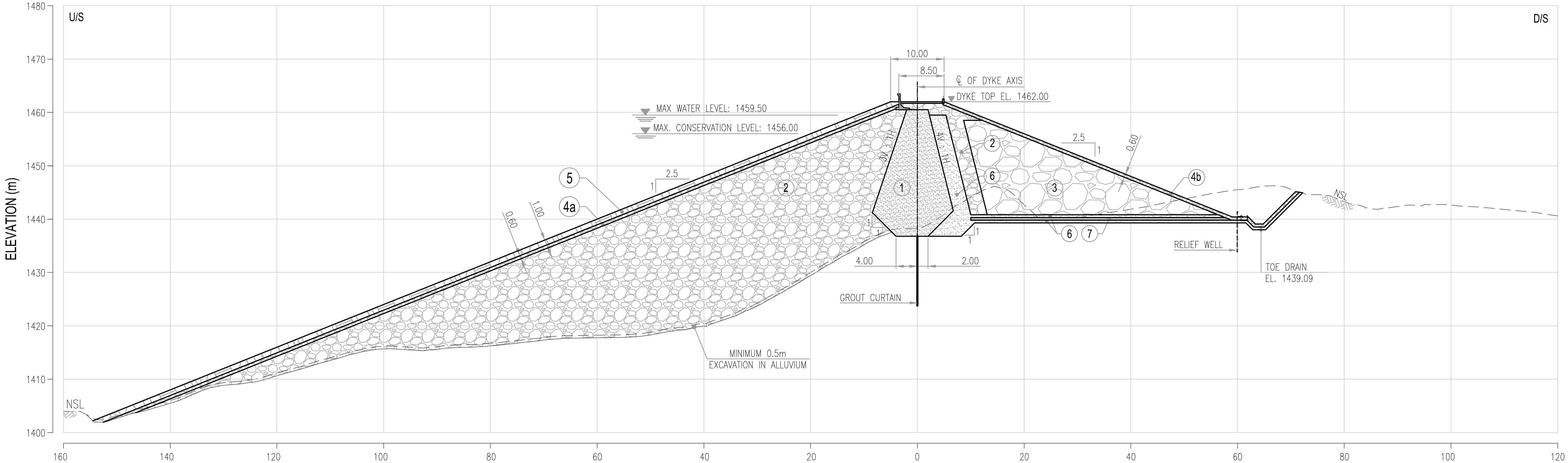
SCALE :
0 10 20 30 40
m

CLIENT :	CONSULTANT:	PROJECT:	DRAWING TITLE :				
ADB ASIAN DEVELOPMENT BANK	Techno-Consult International (Pvt.)Ltd.	BALOCHISTAN WATER RESOURCES DEVELOPMENT PROJECT (TA)	DYKE CROSS SECTIONS AT STATION 0+000 & 0+020	Designed By : ABDUL HAI	Date : NOVEMBER 2017		
		SCHEME: SIRI TOI DAM ZHOB RIVER BASIN		Drawn By : ARSALAN RAFAT	Scale : AS SHOWN		
				Checked By : ZAFAR MASOOD SIDDIQUE	Drg No :		
				Approved By : DR BASHIR LAKHANI	BWRDP-ZRB-STD-DY-251		

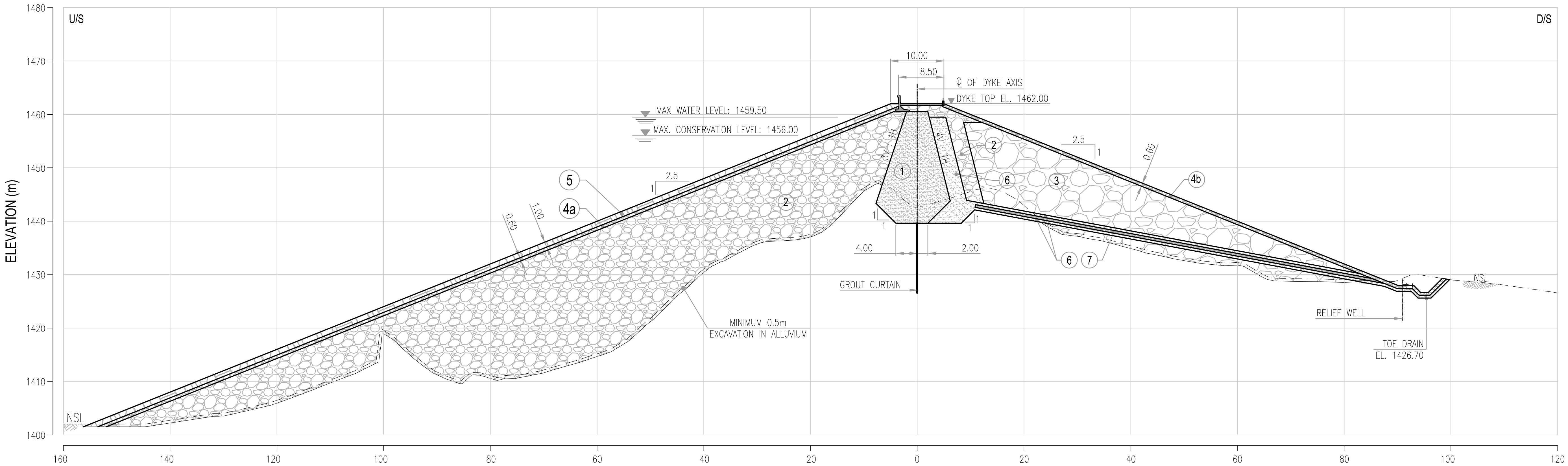
No.	Revision	By	Date

NOTES :

1. ALL DIMENSIONS, STATIONS AND LEVELS ARE IN METERS.
2. CUTOFF TRENCH TO BE EXTENDED DOWN TO THE TOP OF BEDROCK.



CROSS SECTION AT STATION 0+040



CROSS SECTION AT STATION 0+060

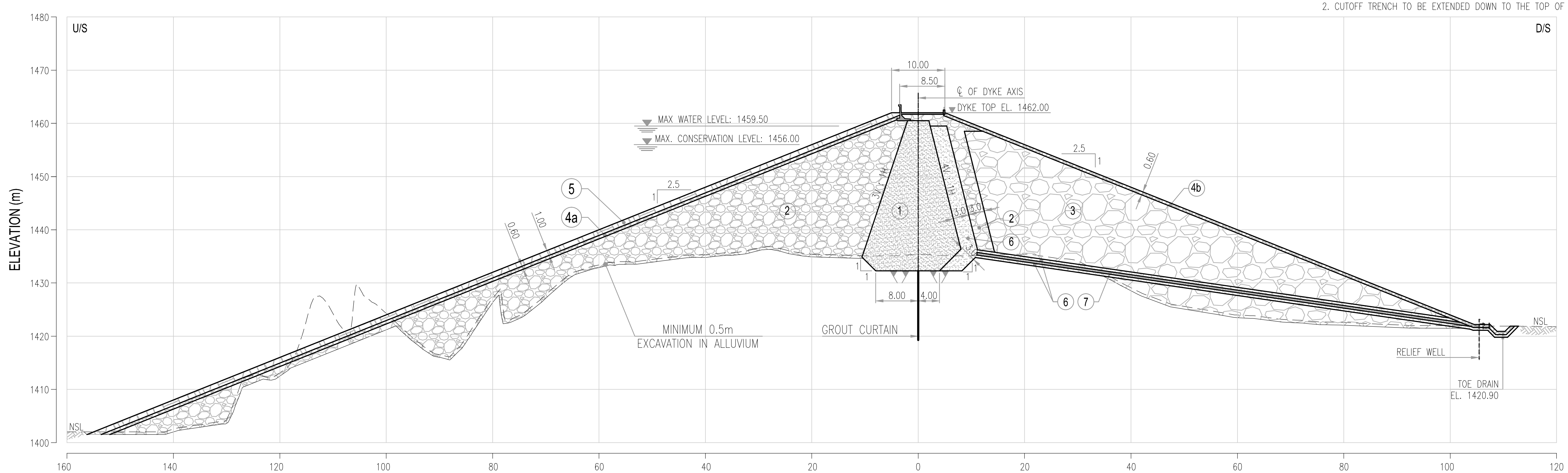
SCALE :
0 10 20 30 40
m

CLIENT :	CONSULTANT:	PROJECT:	DRAWING TITLE :		
ADB ASIAN DEVELOPMENT BANK	Techno-Consult International (Pvt.)Ltd.	BALOCHISTAN WATER RESOURCES DEVELOPMENT PROJECT (TA)	DYKE CROSS SECTIONS AT STATION 0+040 & 0+060	Designed By : ABDUL HAI	Date : NOVEMBER 2017
		SCHEME: SIRI TOI DAM ZHOB RIVER BASIN		Drawn By : ARSALAN RAFAT	Scale : AS SHOWN
				Checked By : ZAFAR MASOOD SIDDIQUE	Drg No :
				Approved By : DR BASHIR LAKHANI	BWRDP-ZRB-STD-DY-252

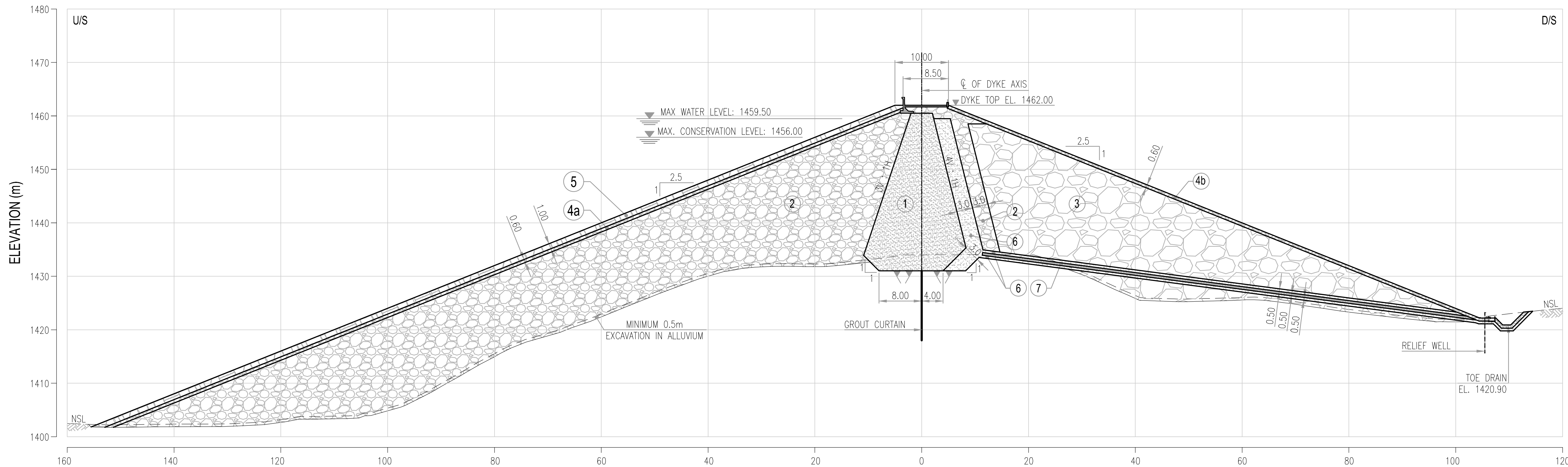
No.	Revision	By	Date

NOTES :

1. ALL DIMENSIONS, STATIONS AND LEVELS ARE IN METERS.
2. CUTOFF TRENCH TO BE EXTENDED DOWN TO THE TOP OF BEDROCK.



CROSS SECTION AT STATION 0+080



CROSS SECTION AT STATION 0+100

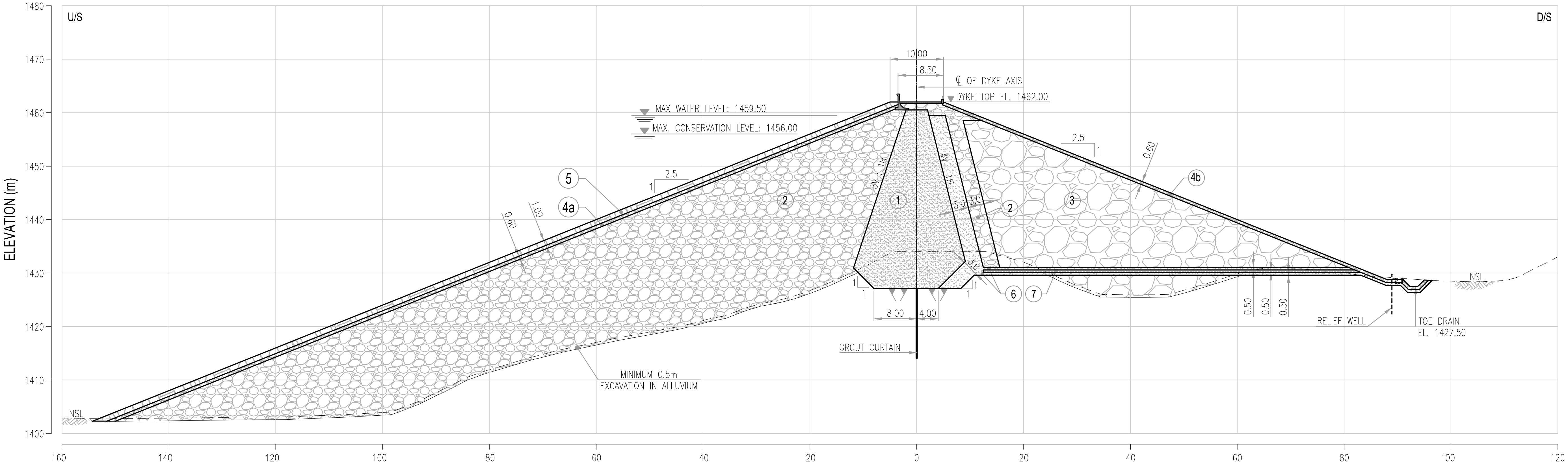
SCALE : 0 10 20 30 40 m

CLIENT : ASIAN DEVELOPMENT BANK	CONSULTANT: Techno-Consult International (Pvt.)Ltd.	PROJECT: BALOCHISTAN WATER RESOURCES DEVELOPMENT PROJECT (TA) SCHEME: SIRI TOI DAM ZHOB RIVER BASIN	DRAWING TITLE : DYKE CROSS SECTIONS AT STATION 0+080 & 0+100	Designed By : ABDUL HAI Drawn By : ARSALAN RAFAT Checked By : ZAFAR MASOOD SIDDIQUE Approved By : DR BASHIR LAKHANI Date : NOVEMBER 2017 Scale : AS SHOWN Drg No : BWRDP-ZRB-STD-DY-253

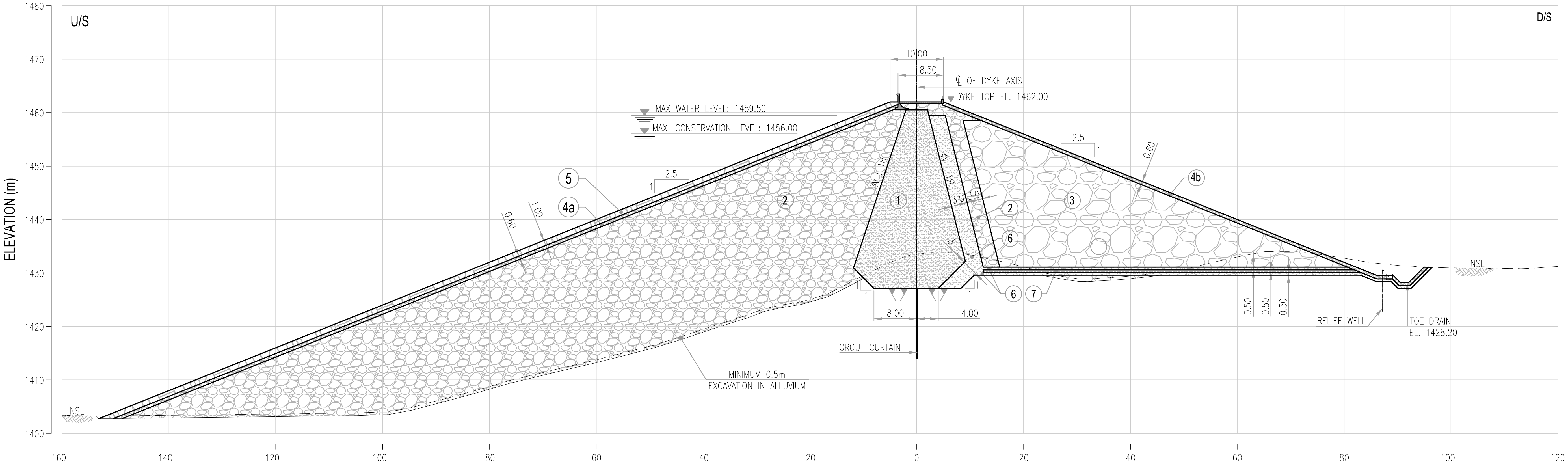
No.	Revision	By	Date

NOTES :

1. ALL DIMENSIONS, STATIONS AND LEVELS ARE IN METERS.
2. CUTOFF TRENCH TO BE EXTENDED DOWN TO THE TOP OF BEDROCK.



CROSS SECTION AT STATION 0+120



CROSS SECTION AT STATION 0+140

SCALE : 0 10 20 30 40 m

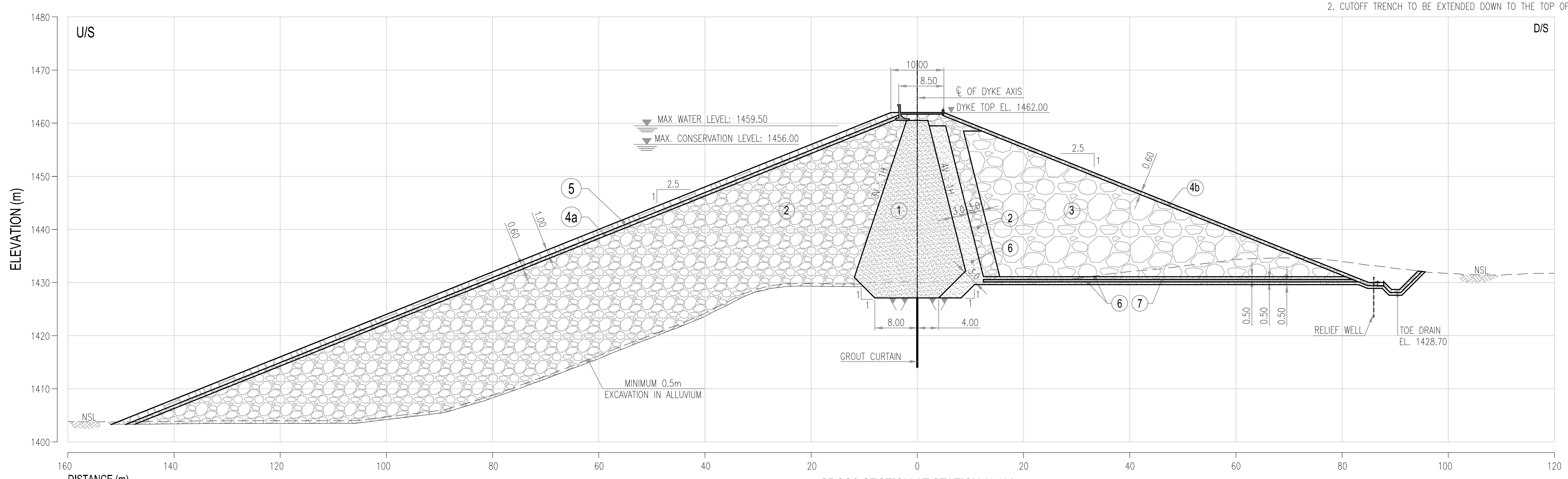
CLIENT : ASIAN DEVELOPMENT BANK	CONSULTANT: Techno-Consult International (Pvt.) Ltd.	PROJECT: BALOCHISTAN WATER RESOURCES DEVELOPMENT PROJECT (TA)	DRAWING TITLE : DYKE CROSS SECTIONS AT STATION 0+120 & 0+140
		SCHEME: SIRI TOI DAM ZHOB RIVER BASIN	

Designed By :	ABDUL HAI	Date :	NOVEMBER 2017
Drawn By :	ARSALAN RAFAT	Scale :	AS SHOWN
Checked By :	ZAFAR MASOOD SIDDIQUE	Drg No :	
Approved By :	DR BASHIR LAKHANI		BWRDP-ZRB-STD-DY-254

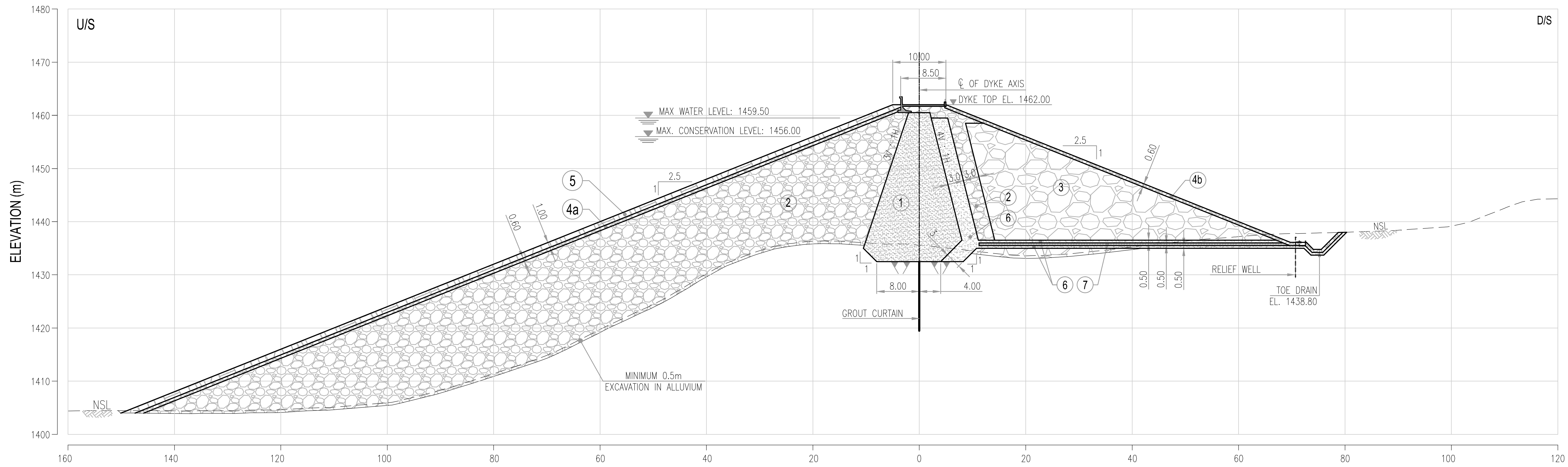
No.	Revision	By	Date

NOTES :

1. ALL DIMENSIONS, STATIONS AND LEVELS ARE IN METERS.
2. CUTOFF TRENCH TO BE EXTENDED DOWN TO THE TOP OF BEDROCK.



CROSS SECTION AT STATION 0+160



CROSS SECTION AT STATION 0+180

SCALE :
0 10 20 30 40
m

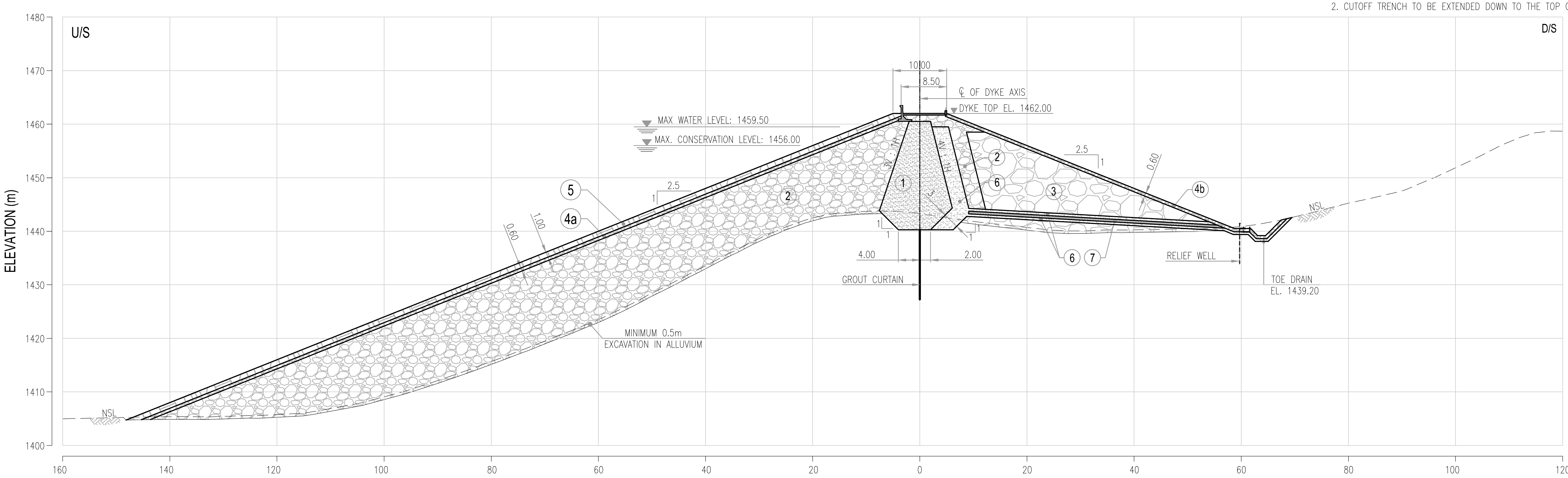
CLIENT : ASIAN DEVELOPMENT BANK	CONSULTANT: Techno-Consult International (Pvt.)Ltd.	PROJECT: BALOCHISTAN WATER RESOURCES DEVELOPMENT PROJECT (TA) SCHEME: SIRI TOI DAM ZHOB RIVER BASIN	DRAWING TITLE : DYKE CROSS SECTIONS AT STATION 0+160 & 0+180

Designed By :	ABDUL HAI	Date :	NOVEMBER 2017
Drawn By :	ARSALAN RAFAT	Scale :	AS SHOWN
Checked By :	ZAFAR MASOOD SIDDIQUE	Drg No :	
Approved By :	DR BASHIR LAKHANI		BWRDP-ZRB-STD-DY-255

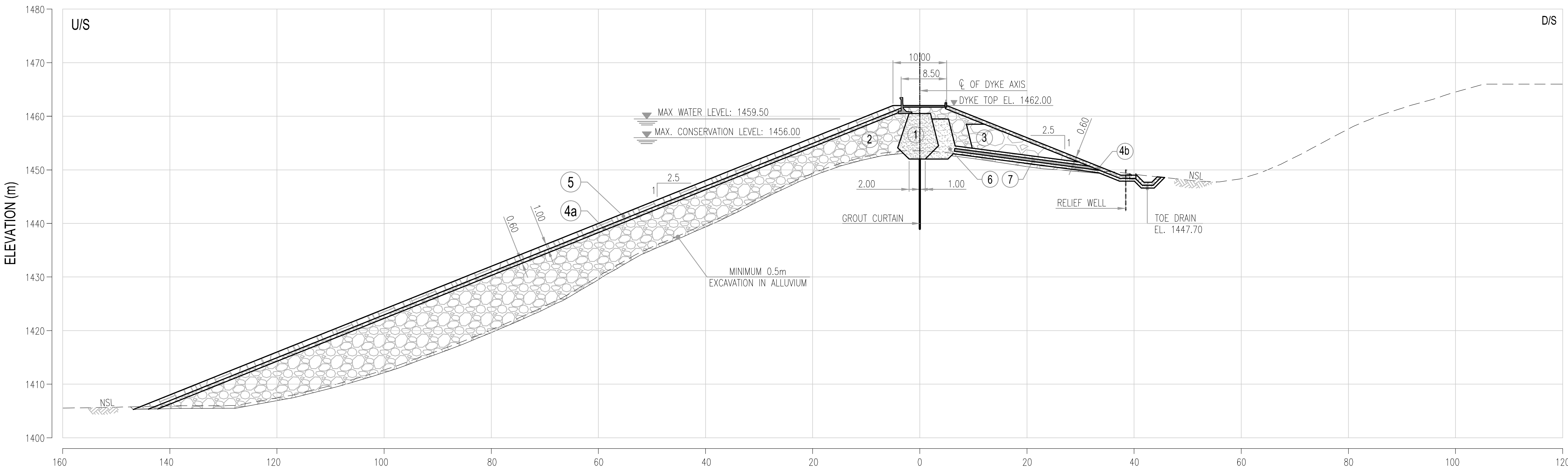
No.	Revision	By	Date

NOTES :

1. ALL DIMENSIONS, STATIONS AND LEVELS ARE IN METERS.
2. CUTOFF TRENCH TO BE EXTENDED DOWN TO THE TOP OF BEDROCK.



CROSS SECTION AT STATION 0+200



CROSS SECTION AT STATION 0+220

SCALE :

0 10 20 30 40 m

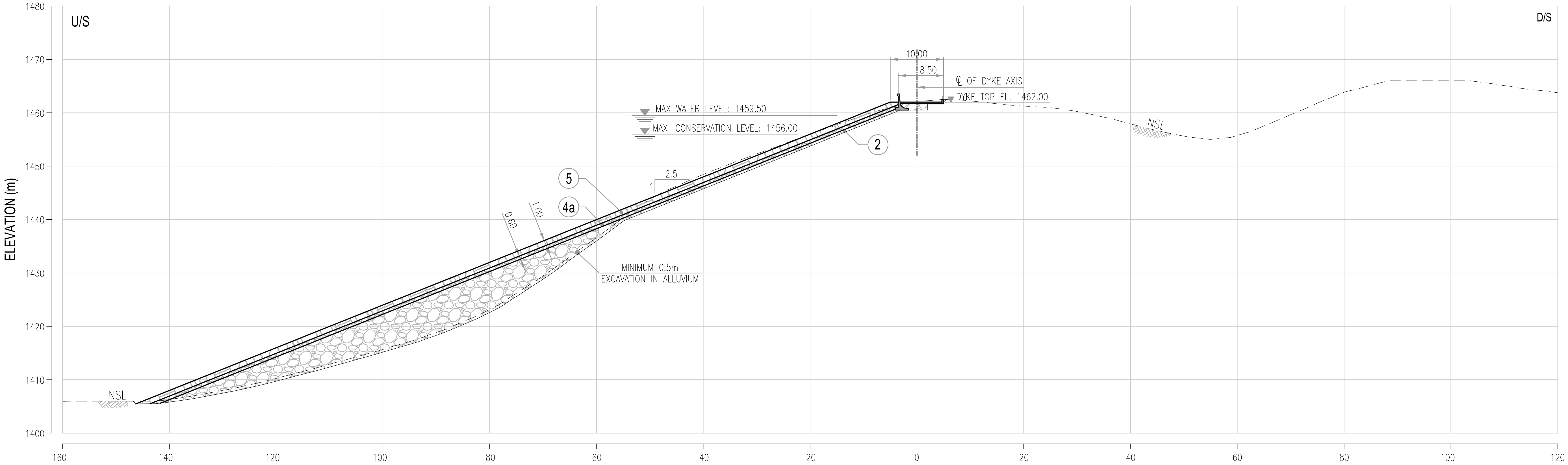
CLIENT : ADB ASIAN DEVELOPMENT BANK	CONSULTANT: Techno-Consult International (Pvt.)Ltd.	PROJECT: BALOCHISTAN WATER RESOURCES DEVELOPMENT PROJECT (TA)	DRAWING TITLE : DYKE CROSS SECTIONS AT STATION 0+200 & 0+220	Designed By : ABDUL HAI
		SCHEME: SIRI TOI DAM ZHOB RIVER BASIN		Drawn By : ARSALAN RAFAT
				Checked By : ZAFAR MASOOD SIDDIQUE
				Approved By : DR BASHIR LAKHANI

Date :	NOVEMBER 2017
Scale :	AS SHOWN
Drg No :	BWRDP-ZRB-STD-DY-256

No.	Revision	By	Date

NOTES :

1. ALL DIMENSIONS, STATIONS AND LEVELS ARE IN METERS.
2. CUTOFF TRENCH TO BE EXTENDED DOWN TO THE TOP OF BEDROCK.



CROSS SECTION AT STATION 0+234.67

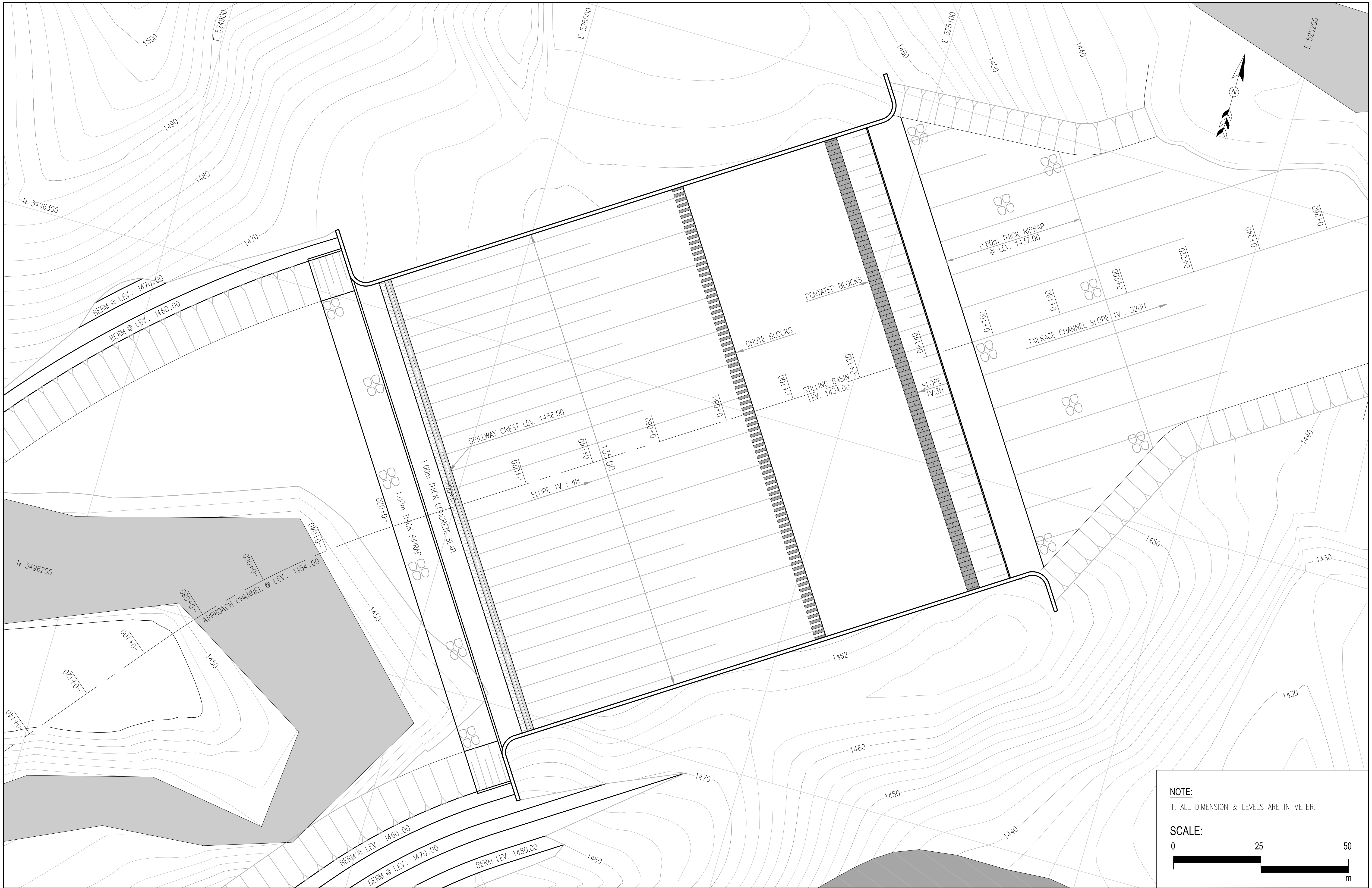
SCALE : 0 10 20 30 40 m

CLIENT :	CONSULTANT:	PROJECT:	DRAWING TITLE :				
ADB ASIAN DEVELOPMENT BANK	Techno-Consult International (Pvt.)Ltd.	BALOCHISTAN WATER RESOURCES DEVELOPMENT PROJECT (TA)	DYKE CROSS SECTIONS AT STATION 0+234.67	Designed By : ABDUL HAI	Date : NOVEMBER 2017		
				Drawn By : ARSALAN RAFAT	Scale : AS SHOWN		
		SCHEME: SIRI TOI DAM ZHOB RIVER BASIN		Checked By : ZAFAR MASOOD SIDDIQUE	Drg No :		
				Approved By : DR BASHIR LAKHANI	BWRDP-ZRB-STD-DY-257		

No.	Revision	By	Date

SIRI TOI DAM

SPILLWAY



NOTE:

1. ALL DIMENSION & LEVELS ARE IN METER.

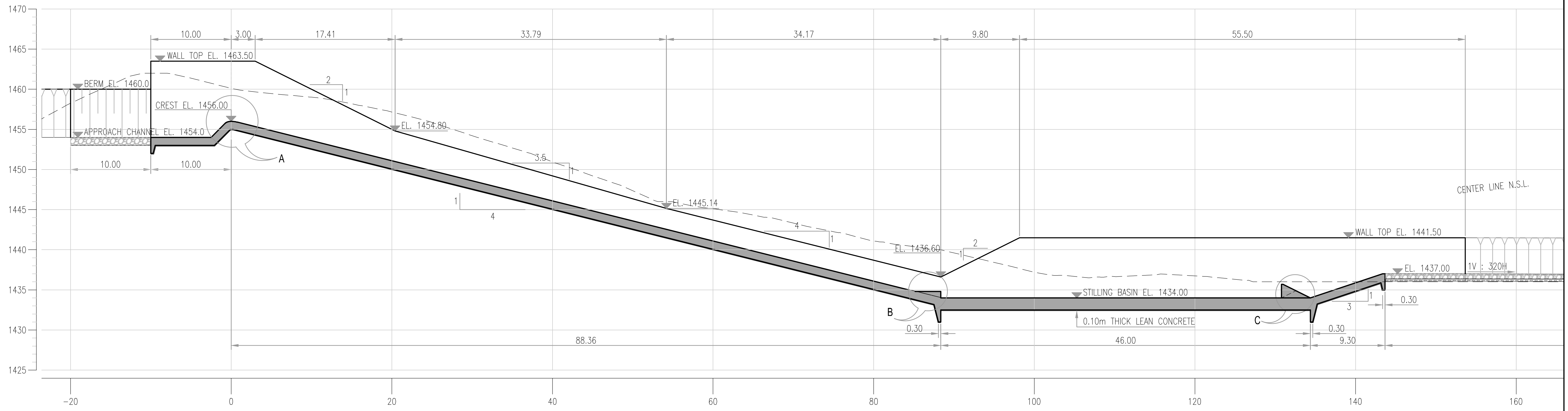
SCALE:

0 25 50 m

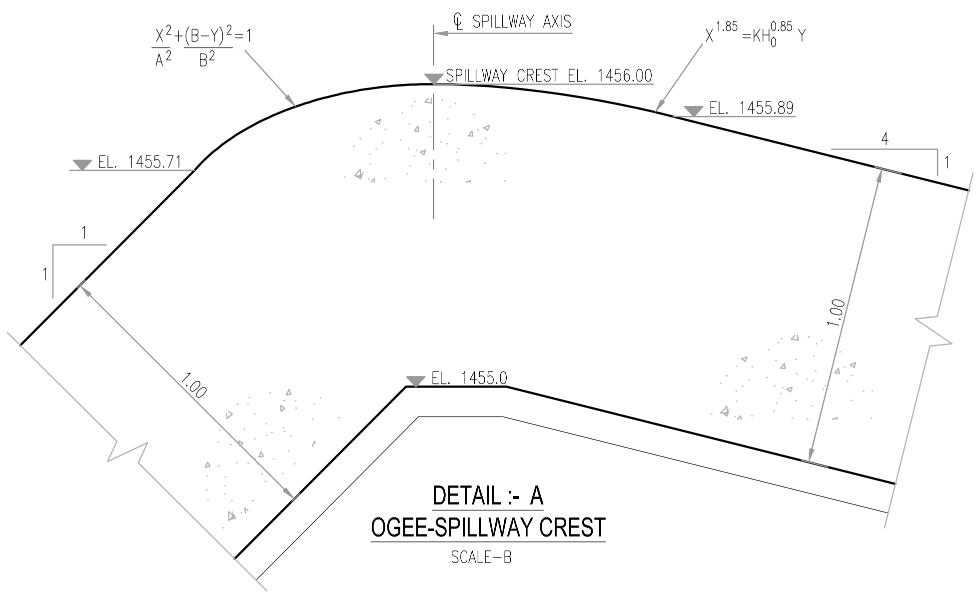
CLIENT :	CONSULTANT :	PROJECT:	DRAWING TITLE :				
ADB ASIAN DEVELOPMENT BANK	Techno-Consult International (Pvt.)Ltd.	BALOCHISTAN WATER RESOURCES DEVELOPMENT PROJECT (TA)	SPILLWAY LAYOUT PLAN	Designed By :	ABDUL HAI	Date :	NOVEMBER 2017
				Drawn By :	ARSALAN RAFAT	Scale :	AS SHOWN
		SCHEME: SIRI TOI DAM ZHOB RIVER BASIN		Checked By :	ZAFAR MASOOD SIDDIQUE	Drg No :	
				Approved By :	DR BASHIR LAKHANI		BWRDP-ZRB-STD-SP-301

No.	Revision	By	Date

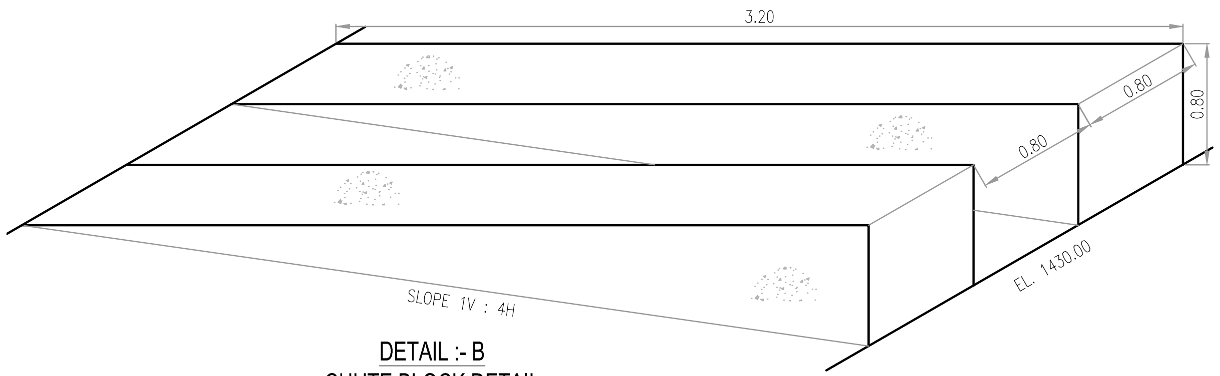
NOTE:
1. ALL DIMENSIONS & LEVELS ARE IN METER.



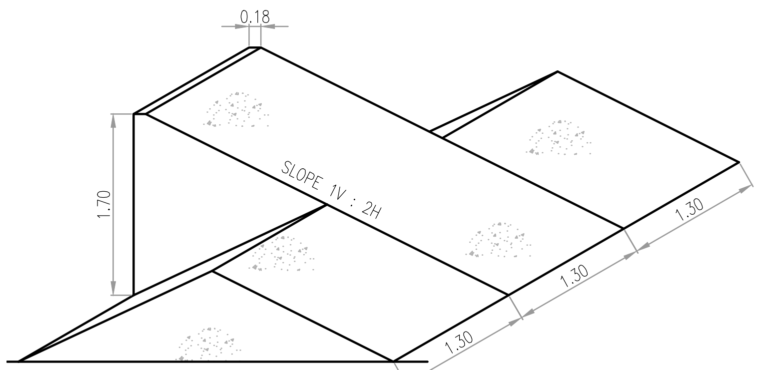
LONGITUDINAL SECTION
SCALE-A



DETAIL :- A
OGEE-SPILLWAY CREST
SCALE-B



DETAIL :- B
CHUTE BLOCK DETAIL
N.T.S.



DETAIL :- C
DENTATED SILL DETAIL
N.T.S.

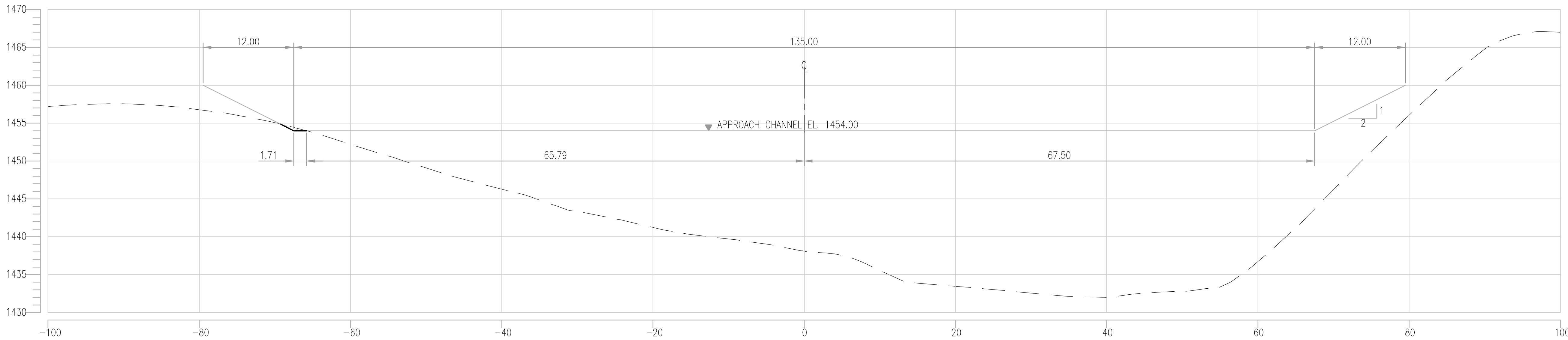
SCALE:- A
0 10 20
m

SCALE:- B
0 0.5 1
m

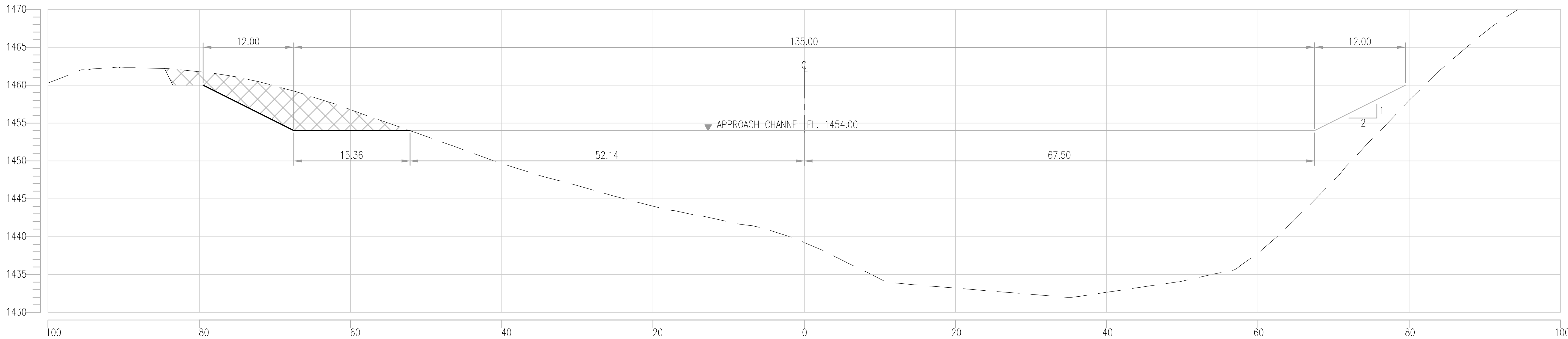
CLIENT : ADB ASIAN DEVELOPMENT BANK	CONSULTANT: Techno-Consult International (Pvt.)Ltd.	PROJECT: BALOCHISTAN WATER RESOURCES DEVELOPMENT PROJECT (TA) SCHEME: SIRI TOI DAM ZHOB RIVER BASIN	DRAWING TITLE : SPILLWAY LONGITUDINAL SECTION	Designed By : ABDUL HAI Drawn By : ARSALAN RAFAT Checked By : ZAFAR MASOOD SIDDIQUE Approved By : DR BASHIR LAKHANI

Date :	NOVEMBER 2017
Scale :	AS SHOWN
Drg No :	BWRDP-ZRB-STD-SP-302

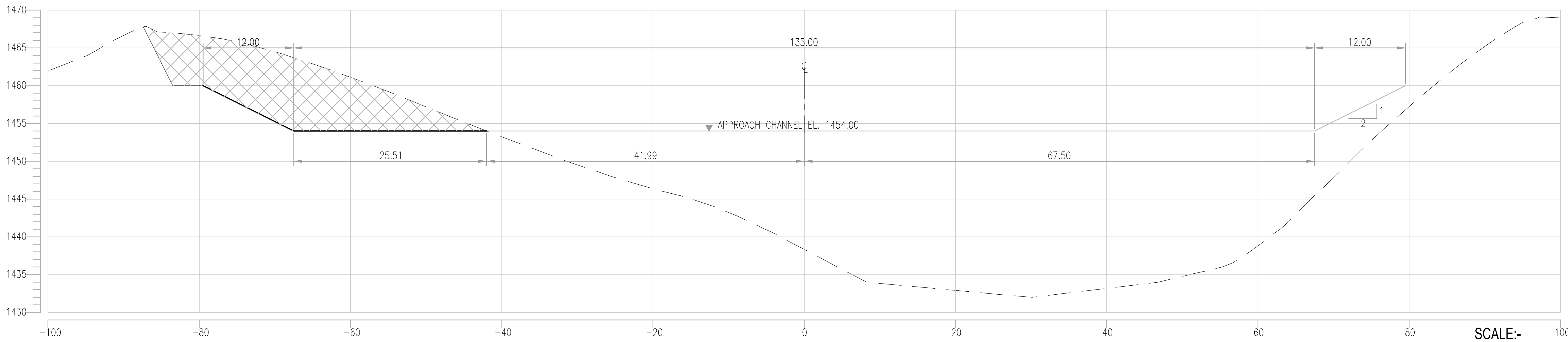
No.	Revision	By	Date



CROSS SECTION AT STA: -0+330



CROSS SECTION AT STA: -0+320



CROSS SECTION AT STA: -0+310

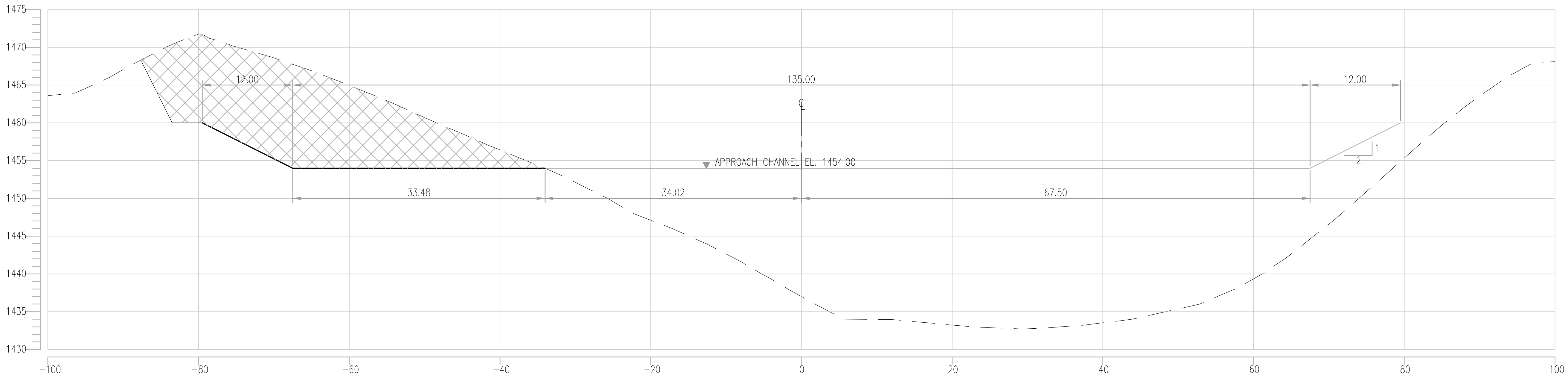
SCALE:-
0 5 10 15 20 25
m

NOTE:

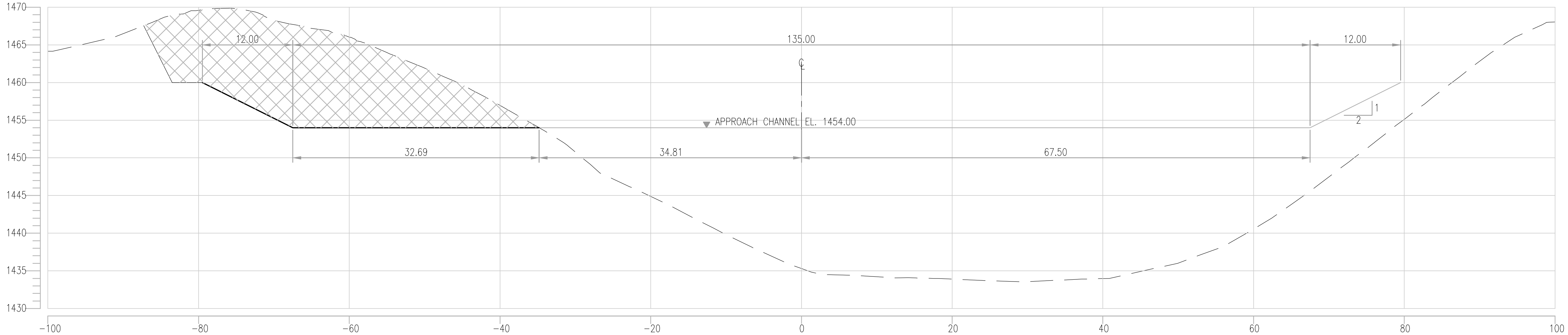
1. ALL DIMENSIONS & LEVELS ARE IN METER.

CLIENT : ADB ASIAN DEVELOPMENT BANK	CONSULTANT: Techno-Consult International (Pvt.)Ltd.	PROJECT: BALOCHISTAN WATER RESOURCES DEVELOPMENT PROJECT (TA) SCHEME: SIRI TOI DAM ZHOB RIVER BASIN	DRAWING TITLE : SPILLWAY CROSS SECTIONS AT STA: -0+330, -0+320 & -0+310	Designed By : ABDUL HAI Drawn By : ARSALAN RAFAT Checked By : ZAFAR MASOOD SIDDIQUE Approved By : DR BASHIR LAKHANI	Date : NOVEMBER 2017 Scale : AS SHOWN Drg No : BWRDP-ZRB-STD-SP-351

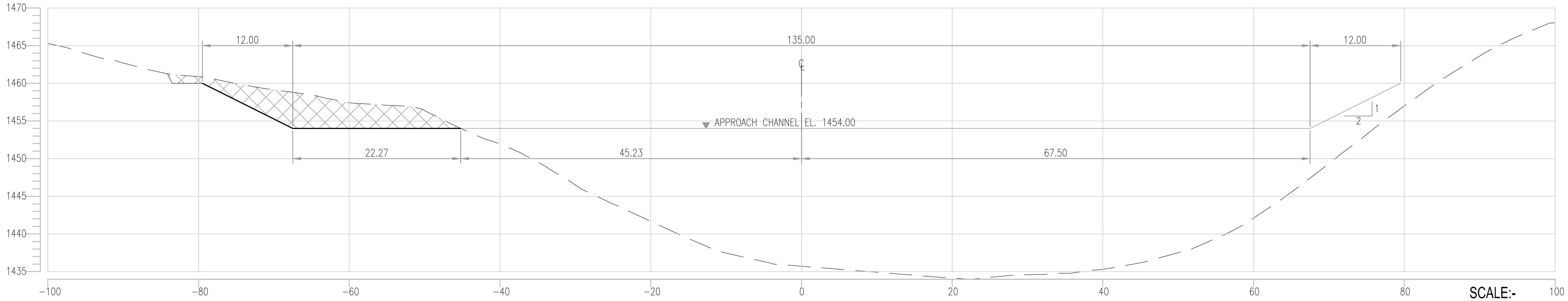
No.	Revision	By	Date



CROSS SECTION AT STA: -0+300



CROSS SECTION AT STA: -0+290



CROSS SECTION AT STA: -0+280

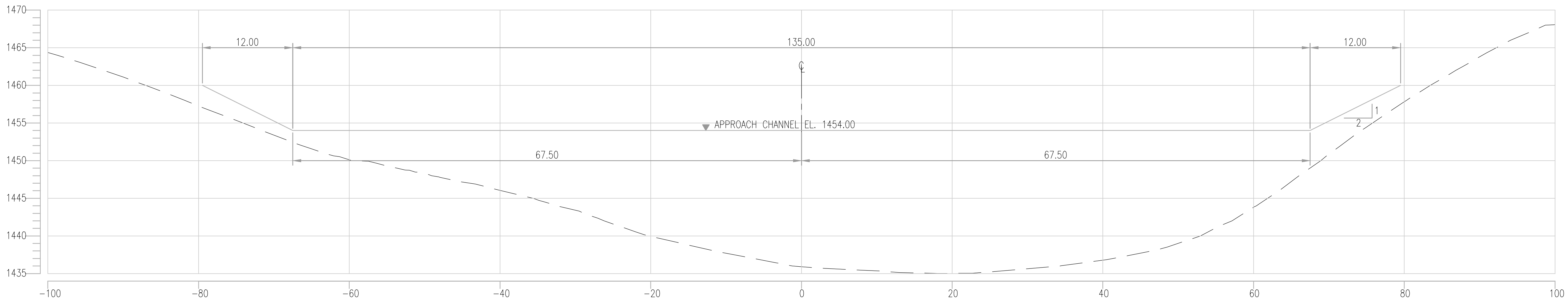
SCALE:-
0 5 10 15 20 25
m

NOTE:

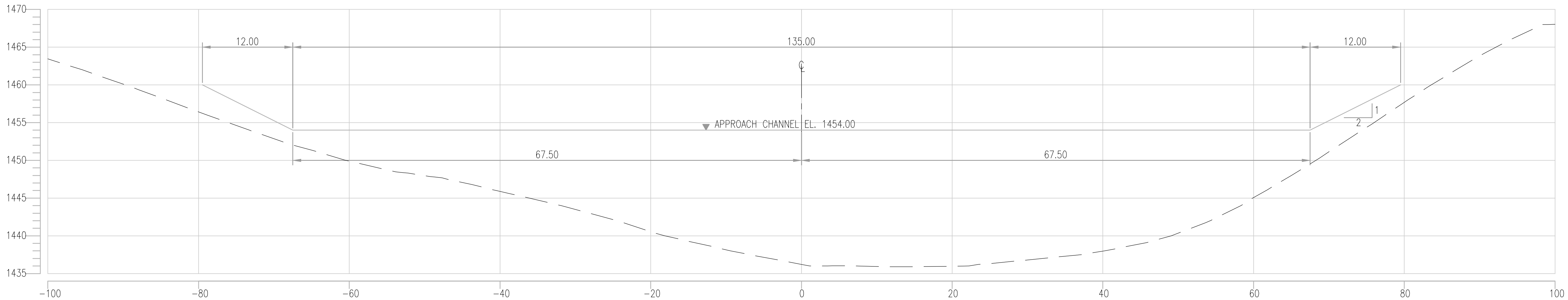
1. ALL DIMENSIONS & LEVELS ARE IN METER.

CLIENT :	CONSULTANT:	PROJECT:	DRAWING TITLE :				
ADB ASIAN DEVELOPMENT BANK	Techno-Consult International (Pvt.)Ltd.	BALOCHISTAN WATER RESOURCES DEVELOPMENT PROJECT (TA)	SPILLWAY CROSS SECTIONS AT STA: -0+300, -0+290 & -0+280	Designed By :	ABDUL HAI	Date :	NOVEMBER 2017
		SCHEME: SIRI TOI DAM ZHOB RIVER BASIN		Drawn By :	ARSALAN RAFAT	Scale :	AS SHOWN
				Checked By :	ZAFAR MASOOD SIDDIQUE	Drg No :	
				Approved By :	DR BASHIR LAKHANI		BWRDP-ZRB-STD-SP-352

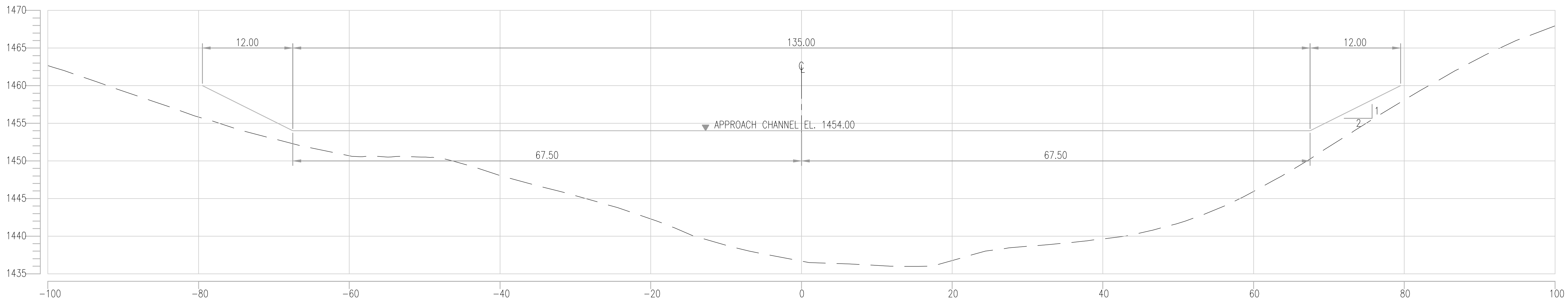
No.	Revision	By	Date



CROSS SECTION AT STA: -0+270



CROSS SECTION AT STA: -0+260



CROSS SECTION AT STA: -0+250

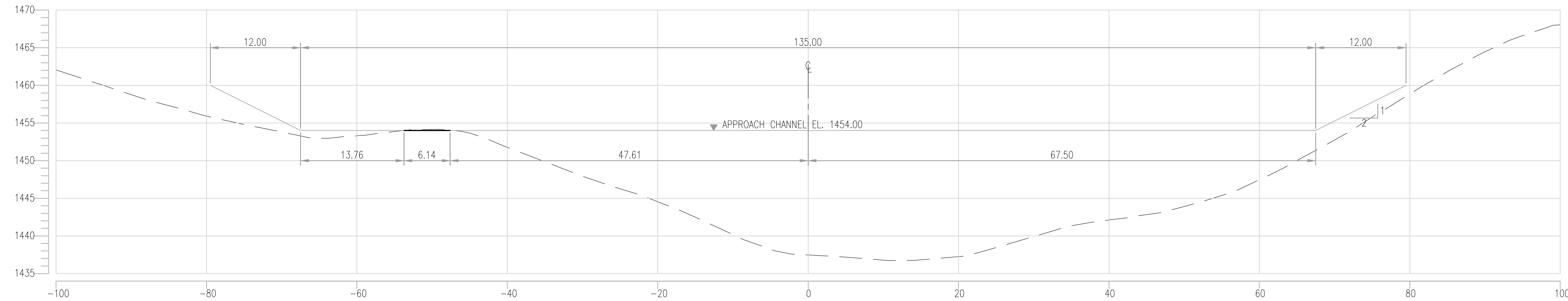
SCALE:-
0 5 10 15 20 25
m

NOTE:

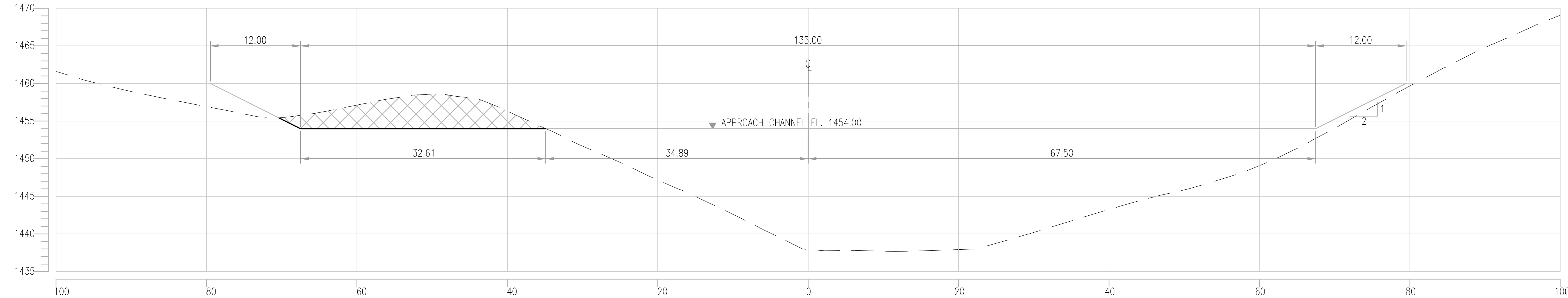
1. ALL DIMENSIONS & LEVELS ARE IN METER.

CLIENT :	CONSULTANT:	PROJECT:	DRAWING TITLE :				
ASIAN DEVELOPMENT BANK	Techno-Consult International (Pvt.)Ltd.	BALOCHISTAN WATER RESOURCES DEVELOPMENT PROJECT (TA)	SPILLWAY CROSS SECTIONS AT STA: -0+270, -0+260 & -0+250	Designed By :	ABDUL HAI	Date :	NOVEMBER 2017
		SCHEME: SIRI TOI DAM ZHOB RIVER BASIN		Drawn By :	ARSALAN RAFAT	Scale :	AS SHOWN
				Checked By :	ZAFAR MASOOD SIDDIQUE	Drg No :	
				Approved By :	DR BASHIR LAKHANI		BWRDP-ZRB-STD-SP-353

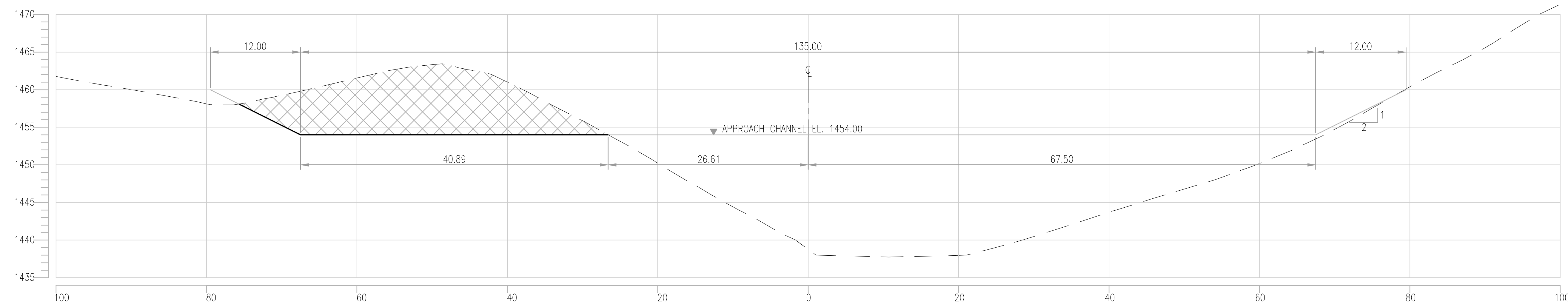
No.	Revision	By	Date



CROSS SECTION AT STA: -0+240

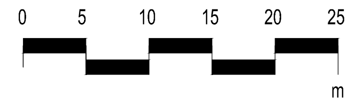


CROSS SECTION AT STA: -0+230



CROSS SECTION AT STA: -0+220

SCALE:-



NOTE:

1. ALL DIMENSIONS & LEVELS ARE IN METER.

CLIENT :

ASIAN DEVELOPMENT BANK

CONSULTANT:

Techno-Consult International (Pvt.)Ltd.

PROJECT:
BALOCHISTAN WATER RESOURCES DEVELOPMENT PROJECT (TA)

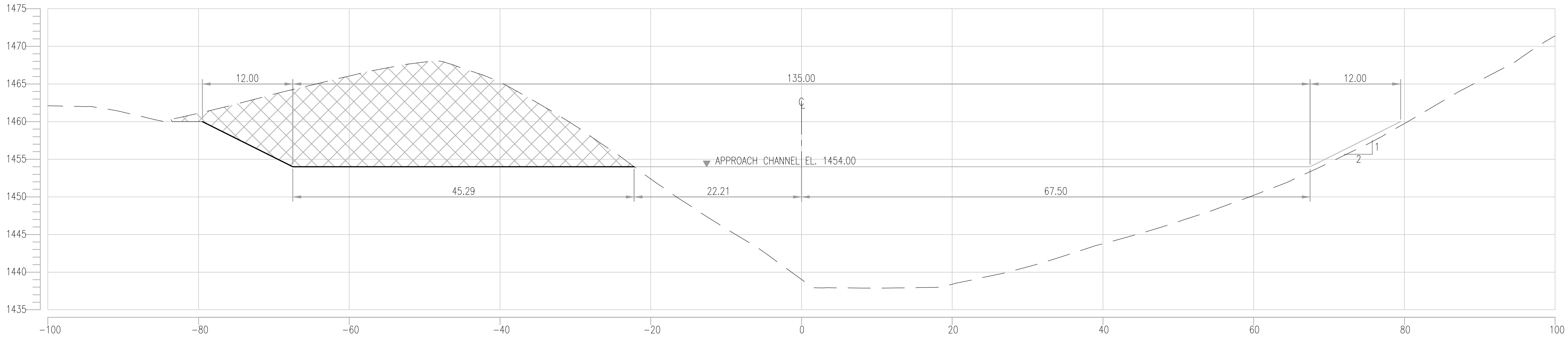
SCHEME:
SIRI TOI DAM
ZHOB RIVER BASIN

DRAWING TITLE :

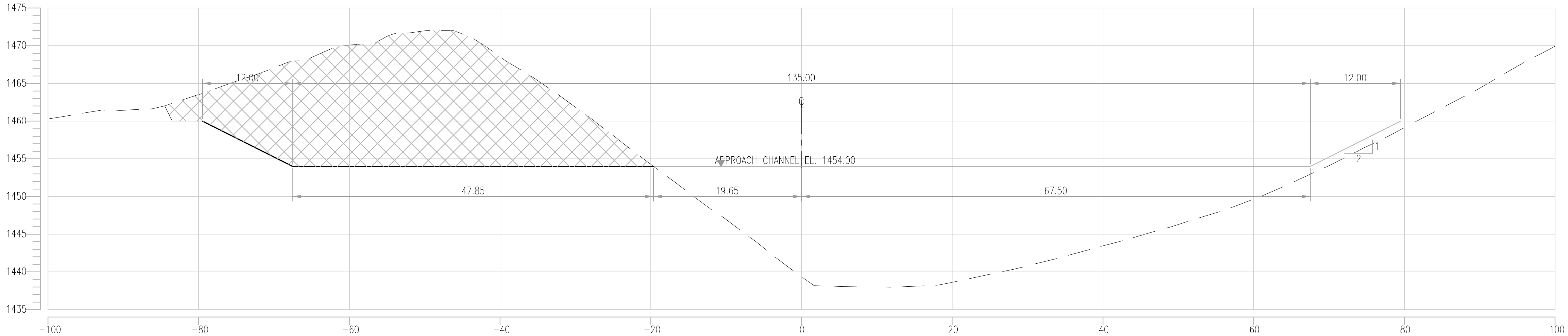
SPILLWAY
CROSS SECTIONS
AT STA: -0+240, -0+230 & -0+220

Designed By :	ABDUL HAI	Date :	NOVEMBER 2017
Drawn By :	ARSALAN RAFAT	Scale :	AS SHOWN
Checked By :	ZAFAR MASOOD SIDDIQUE	Drg No :	
Approved By :	DR BASHIR LAKHANI		BWRDP-ZRB-STD-SP-354

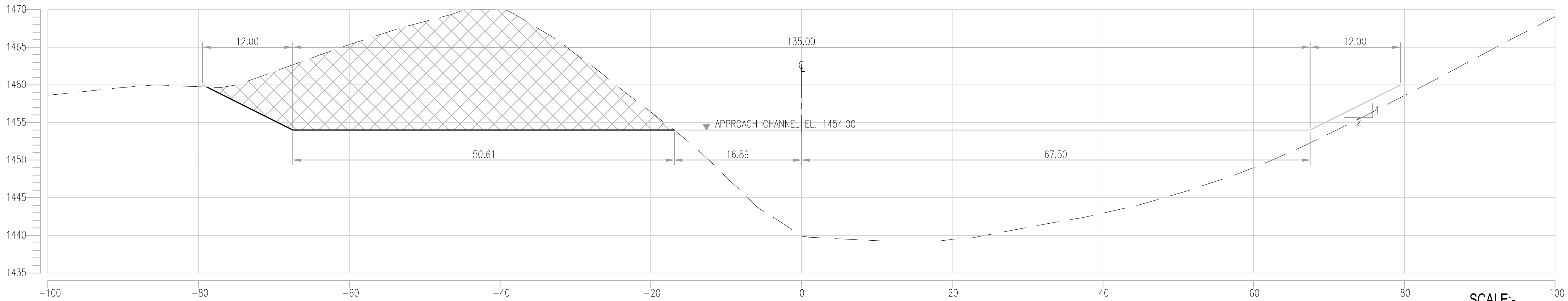
No.	Revision	By	Date



CROSS SECTION AT STA: -0+210



CROSS SECTION AT STA: -0+200



CROSS SECTION AT STA: -0+190

SCALE:-
0 5 10 15 20 25
m

NOTE:
1. ALL DIMENSIONS & LEVELS ARE IN METER.

CLIENT : ADB ASIAN DEVELOPMENT BANK

CONSULTANT: Techno-Consult International (Pvt.)Ltd.

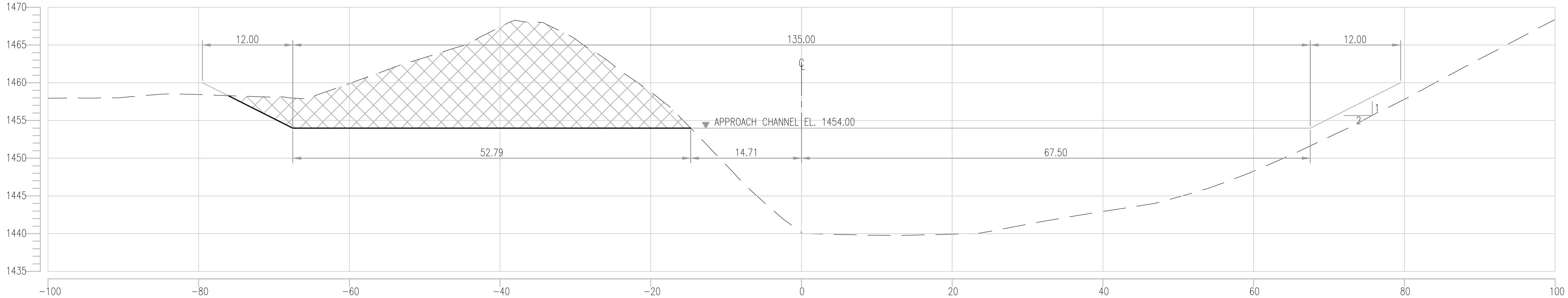
PROJECT: BALOCHISTAN WATER RESOURCES DEVELOPMENT PROJECT (TA)

SCHEME: SIRI TOI DAM ZHOB RIVER BASIN

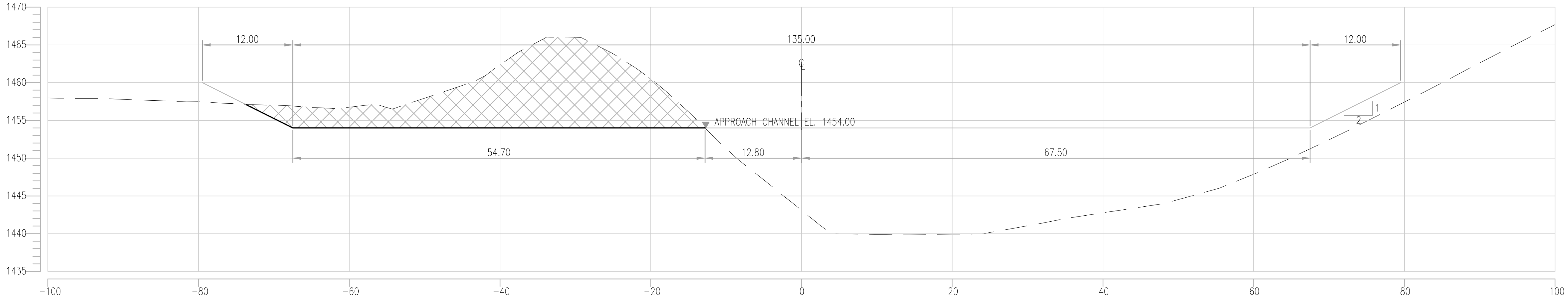
DRAWING TITLE : SPILLWAY CROSS SECTIONS AT STA: -0+210, -0+200 & -0+190

Designed By :	ABDUL HAI	Date :	NOVEMBER 2017
Drawn By :	ARSALAN RAFAT	Scale :	AS SHOWN
Checked By :	ZAFAR MASOOD SIDDIQUE	Drg No :	
Approved By :	DR BASHIR LAKHANI		BWRDP-ZRB-STD-SP-355

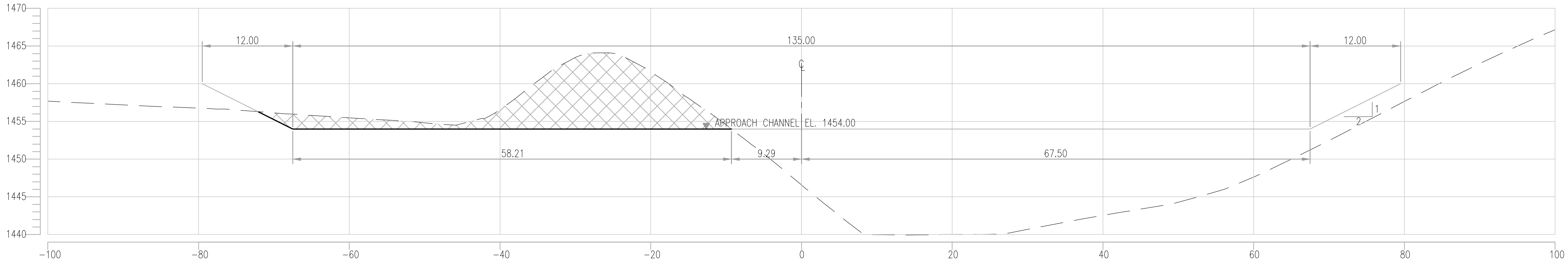
No.	Revision	By	Date



CROSS SECTION AT STA: -0+180

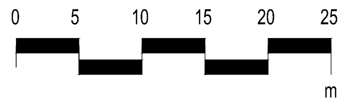


CROSS SECTION AT STA: -0+170



CROSS SECTION AT STA: -0+160

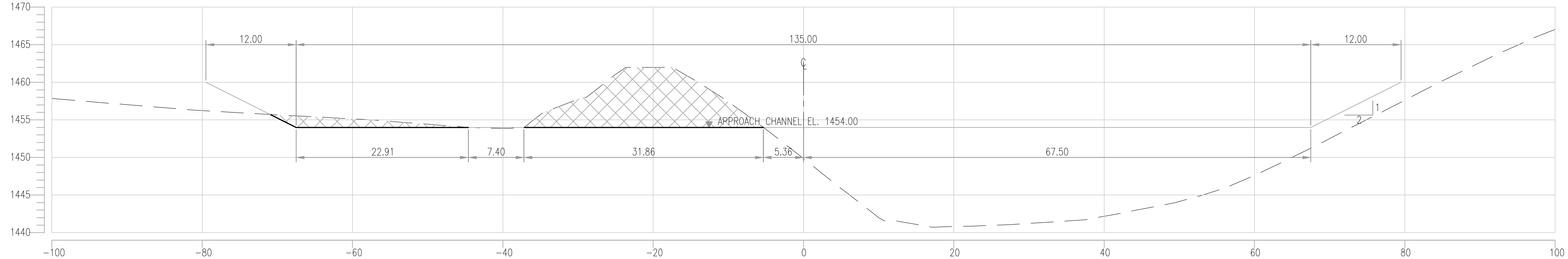
SCALE:-



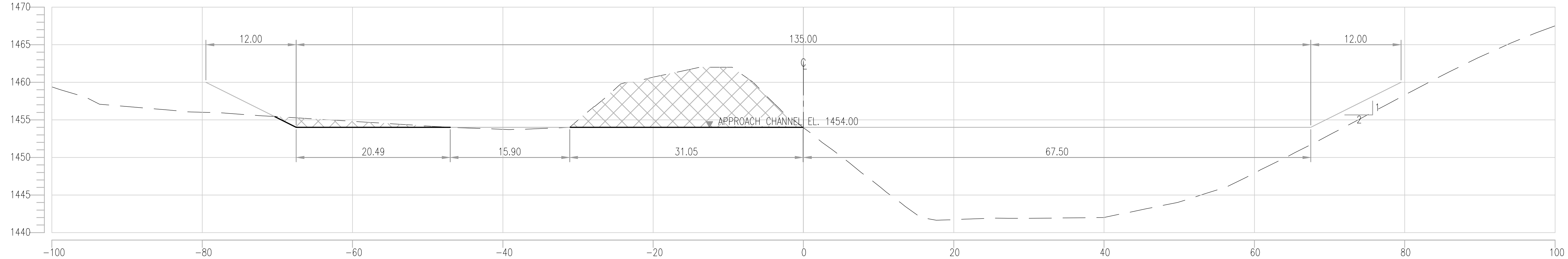
NOTE:

1. ALL DIMENSIONS & LEVELS ARE IN METER.

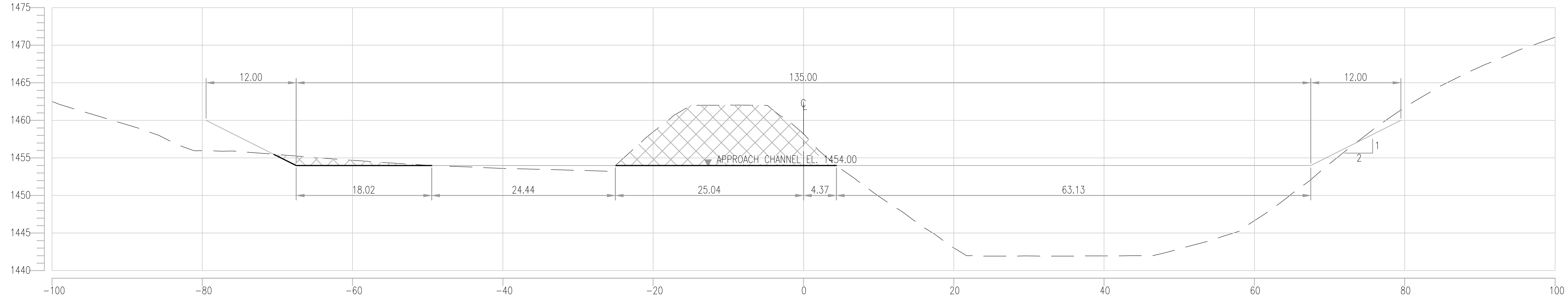
CLIENT : ASIAN DEVELOPMENT BANK	CONSULTANT: Techno-Consult International (Pvt.)Ltd.	PROJECT: BALOCHISTAN WATER RESOURCES DEVELOPMENT PROJECT (TA)	DRAWING TITLE : SPILLWAY CROSS SECTIONS AT STA: -0+180, -0+170 & -0+160	Designed By : ABDUL HAI	Date : NOVEMBER 2017	No. / Revision / By / Date
		SCHEME: SIRI TOI DAM ZHOB RIVER BASIN		Drawn By : ARSALAN RAFAT	Scale : AS SHOWN	
				Checked By : ZAFAR MASOOD SIDDIQUE	Drg No : BWRDP-ZRB-STD-SP-356	
				Approved By : DR BASHIR LAKHANI		



CROSS SECTION AT STA: -0+150



CROSS SECTION AT STA: -0+140



CROSS SECTION AT STA: -0+130

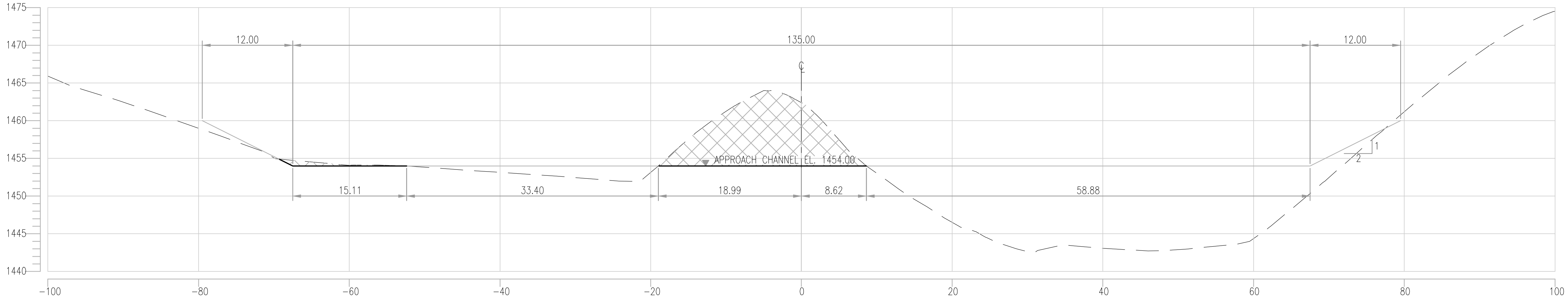
SCALE:-
0 5 10 15 20 25
m

NOTE:
1. ALL DIMENSIONS & LEVELS ARE IN METER.

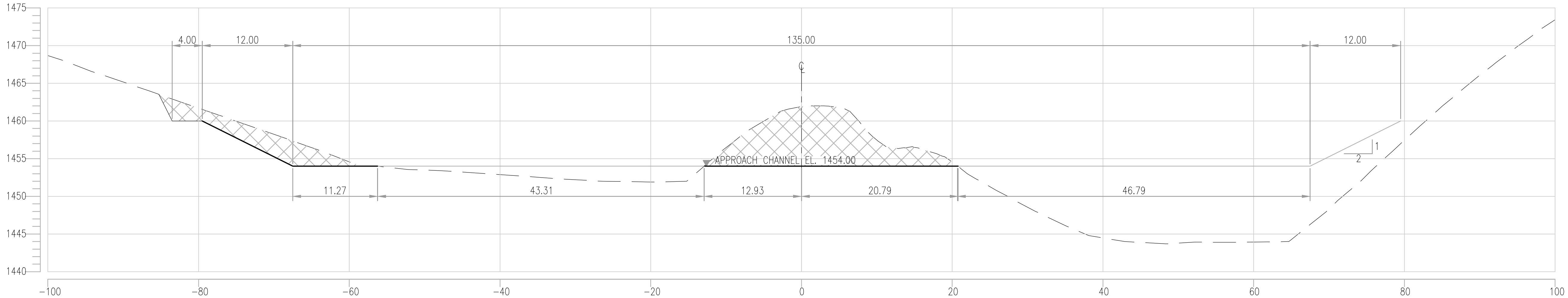
CLIENT : ASIAN DEVELOPMENT BANK	CONSULTANT: Techno-Consult International (Pvt.)Ltd.	PROJECT: BALOCHISTAN WATER RESOURCES DEVELOPMENT PROJECT (TA)	DRAWING TITLE : SPILLWAY CROSS SECTIONS AT STA: -0+150, -0+140 & -0+130	
		SCHEME: SIRI TOI DAM ZHOB RIVER BASIN		

Designed By :	ABDUL HAI	Date :	NOVEMBER 2017
Drawn By :	ARSALAN RAFAT	Scale :	AS SHOWN
Checked By :	ZAFAR MASOOD SIDDIQUE	Drg No :	
Approved By :	DR BASHIR LAKHANI		BWRDP-ZRB-STD-SP-357

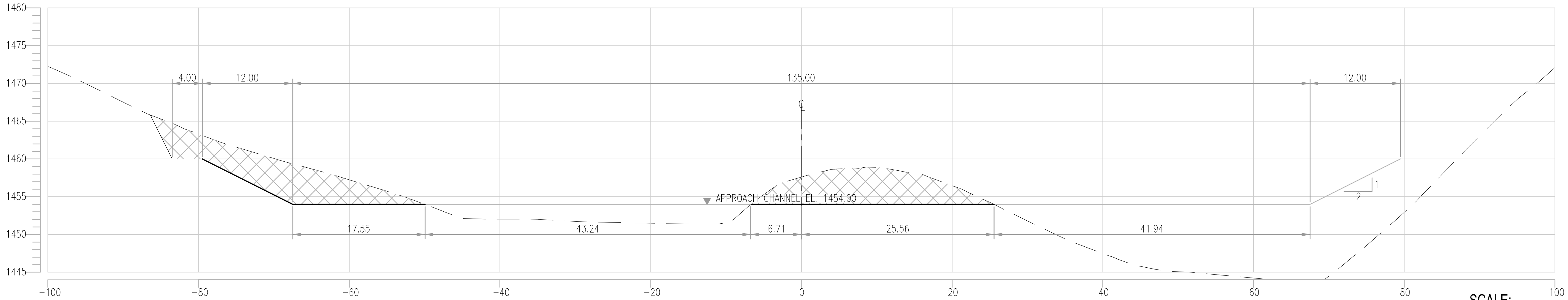
No.	Revision	By	Date



CROSS SECTION AT STA: -0+120



CROSS SECTION AT STA: -0+110

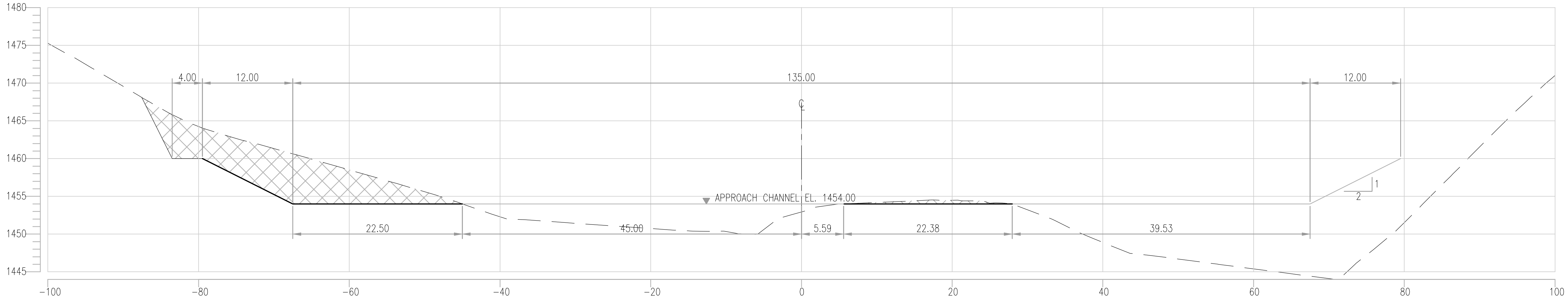


CROSS SECTION AT STA: -0+100

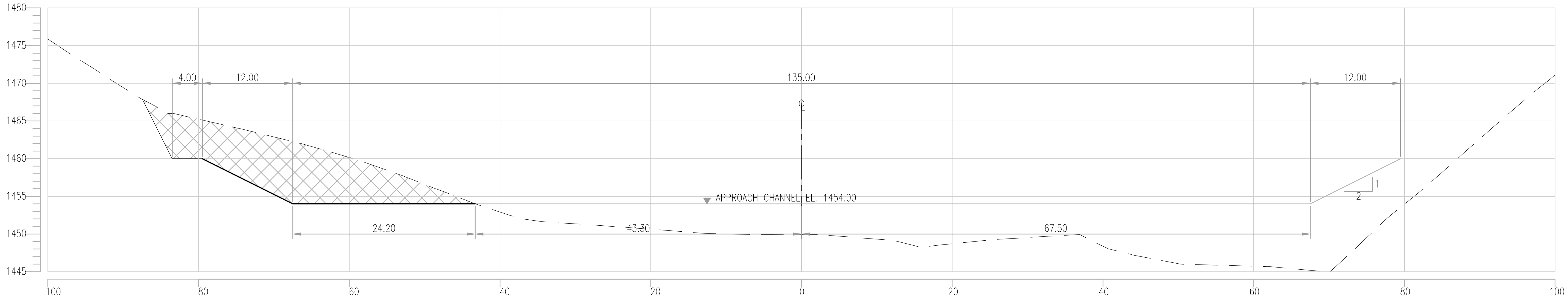
SCALE:-
0 5 10 15 20 25
m

NOTE:
1. ALL DIMENSIONS & LEVELS ARE IN METER.

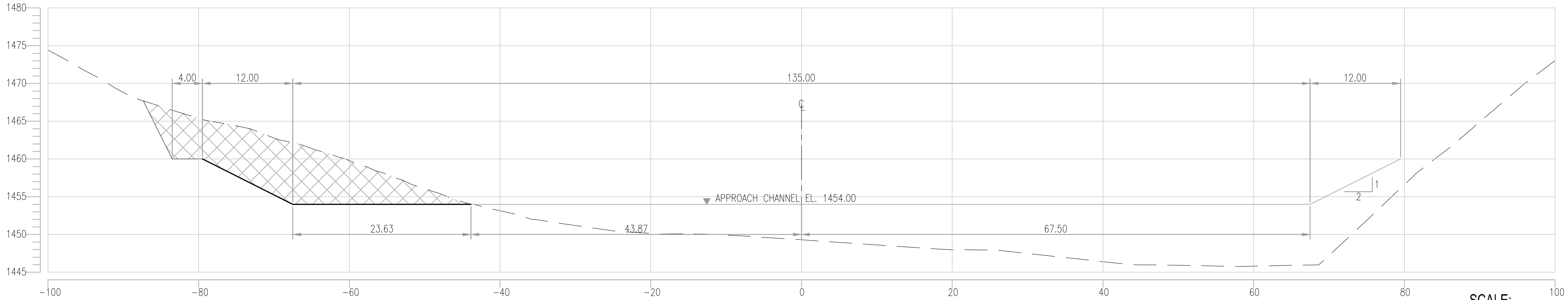
CLIENT :	CONSULTANT:	PROJECT:	DRAWING TITLE :					
ADB ASIAN DEVELOPMENT BANK	Techno-Consult International (Pvt.)Ltd.	BALOCHISTAN WATER RESOURCES DEVELOPMENT PROJECT (TA)	SPILLWAY CROSS SECTIONS AT STA: -0+120, -0+110 & -0+100	Designed By : ABDUL HAI	Date : NOVEMBER 2017	No.	Revision	By	Date
		SCHEME: SIRI TOI DAM ZHOB RIVER BASIN		Drawn By : ARSALAN RAFAT	Scale : AS SHOWN				
				Checked By : ZAFAR MASOOD SIDDIQUE	Drg No :				
				Approved By : DR BASHIR LAKHANI	BWRDP-ZRB-STD-SP-358				



CROSS SECTION AT STA: -0+090

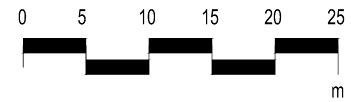


CROSS SECTION AT STA: -0+080



CROSS SECTION AT STA: -0+070

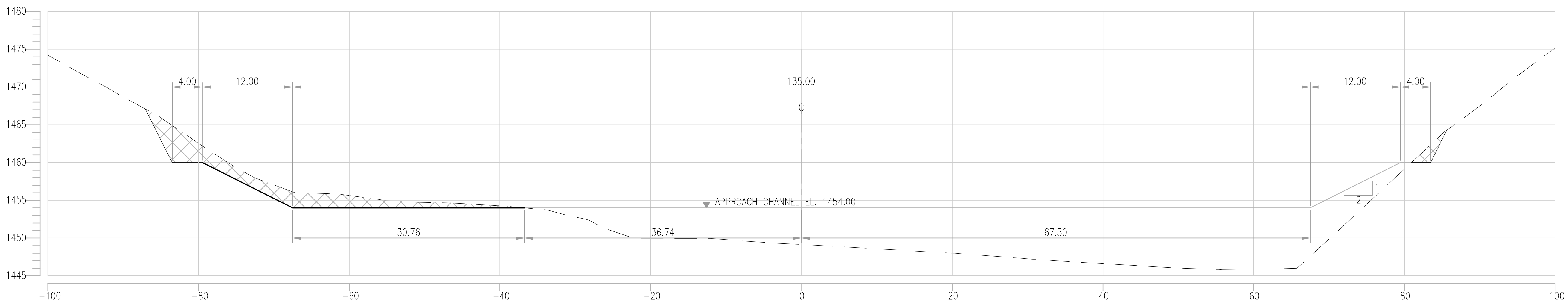
SCALE:-



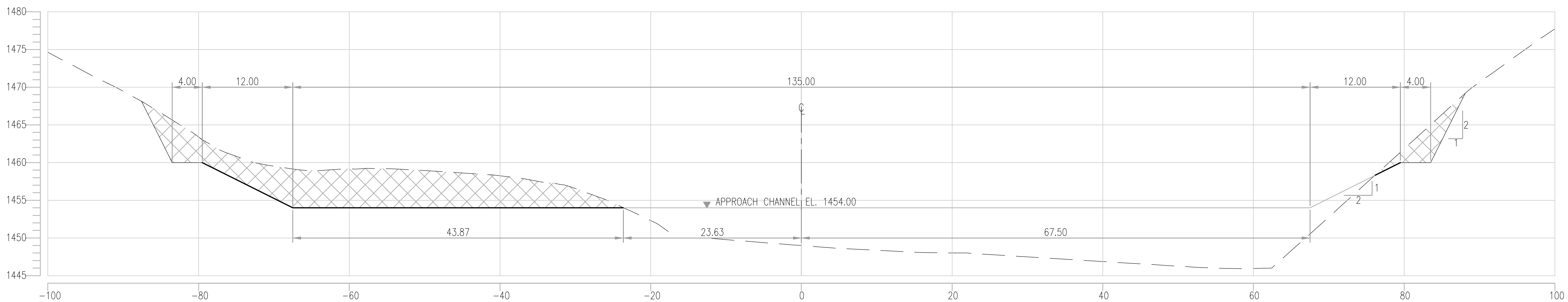
NOTE:

1. ALL DIMENSIONS & LEVELS ARE IN METER.

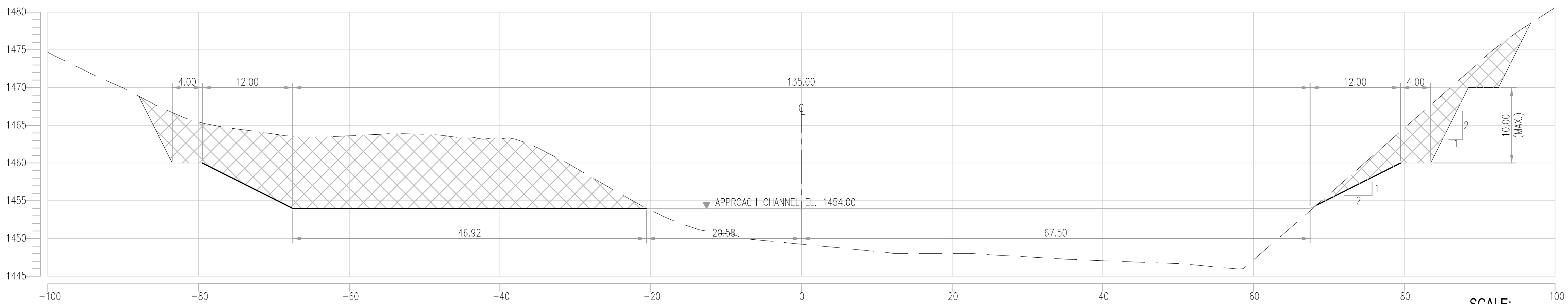
CLIENT :	CONSULTANT:	PROJECT:	DRAWING TITLE :				
ADB ASIAN DEVELOPMENT BANK	Techno-Consult International (Pvt.)Ltd.	BALOCHISTAN WATER RESOURCES DEVELOPMENT PROJECT (TA)	SPILLWAY CROSS SECTIONS AT STA: -0+090, -0+080 & -0+070	Designed By : ABDUL HAI	Date : NOVEMBER 2017	No.	Revision
		SCHEME: SIRI TOI DAM ZHOB RIVER BASIN		Drawn By : ARSALAN RAFAT	Scale : AS SHOWN	By	Date
				Checked By : ZAFAR MASOOD SIDDIQUE	Drg No :		
				Approved By : DR BASHIR LAKHANI	BWRDP-ZRB-STD-SP-359		



CROSS SECTION AT STA: -0+060



CROSS SECTION AT STA: -0+050



CROSS SECTION AT STA: -0+040

SCALE:-

0 5 10 15 20 25

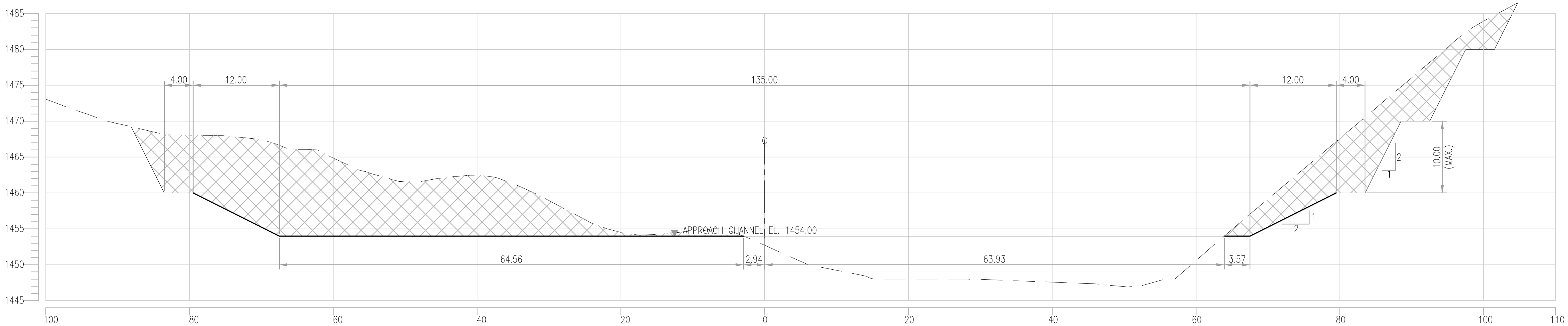
m

NOTE:

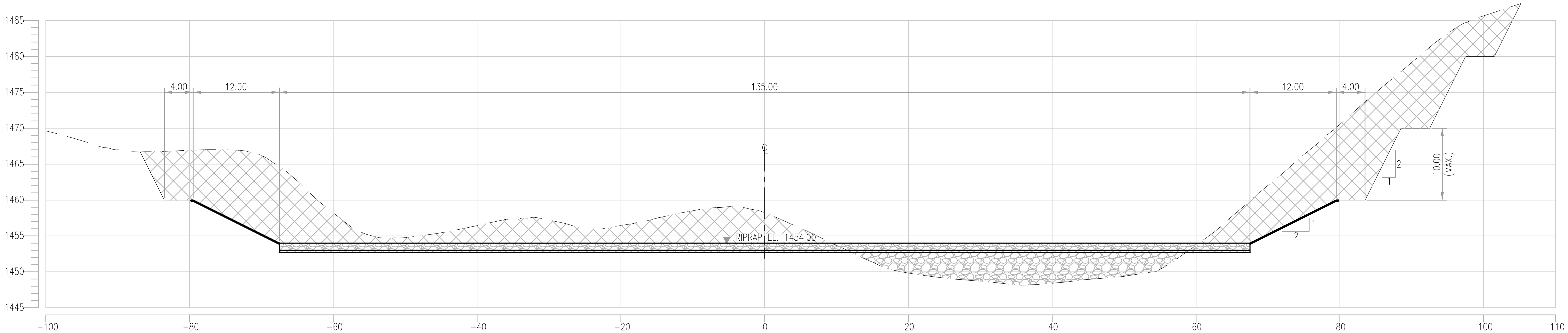
1. ALL DIMENSIONS & LEVELS ARE IN METER.

CLIENT : ASIAN DEVELOPMENT BANK	CONSULTANT: Techno-Consult International (Pvt.)Ltd.	PROJECT: BALOCHISTAN WATER RESOURCES DEVELOPMENT PROJECT (TA)	DRAWING TITLE : SPILLWAY CROSS SECTIONS AT STA: -0+060, -0+050 & -0+040	Designed By : ABDUL HAI	Date : NOVEMBER 2017
		SCHEME: SIRI TOI DAM ZHOB RIVER BASIN		Drawn By : ARSALAN RAFAT	Scale : AS SHOWN
				Checked By : ZAFAR MASOOD SIDDIQUE	Drg No :
				Approved By : DR BASHIR LAKHANI	BWRDP-ZRB-STD-SP-360

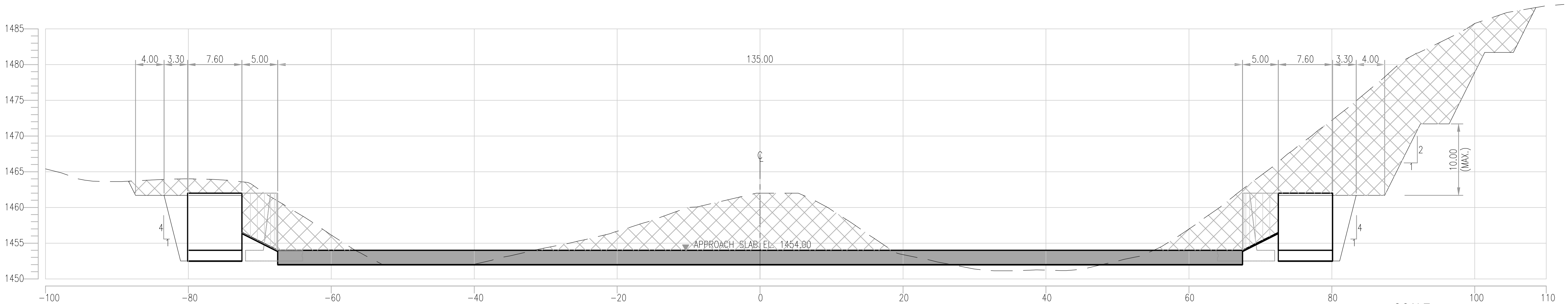
No.	Revision	By	Date



CROSS SECTION AT STA: -0+030



CROSS SECTION AT STA: -0+020



CROSS SECTION AT STA: -0+010

SCALE:-

0 5 10 15 20 25

m

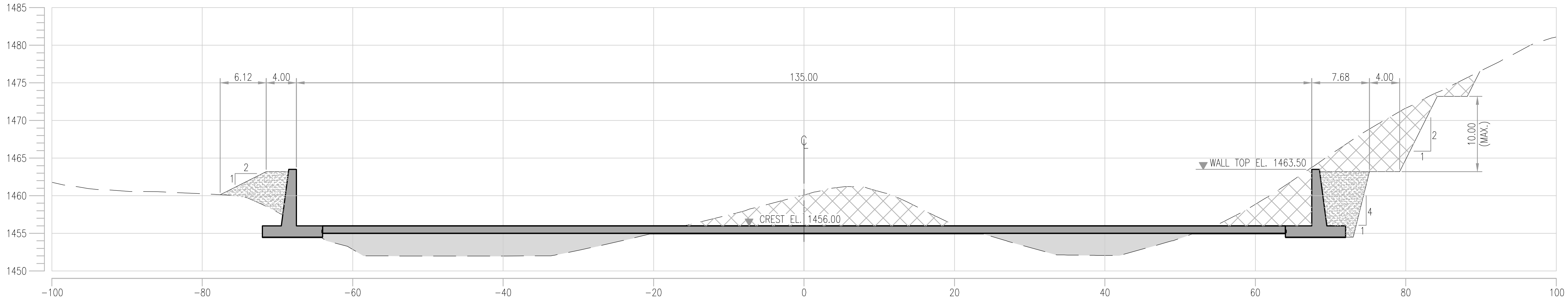
NOTE:

1. ALL DIMENSIONS & LEVELS ARE IN METER.

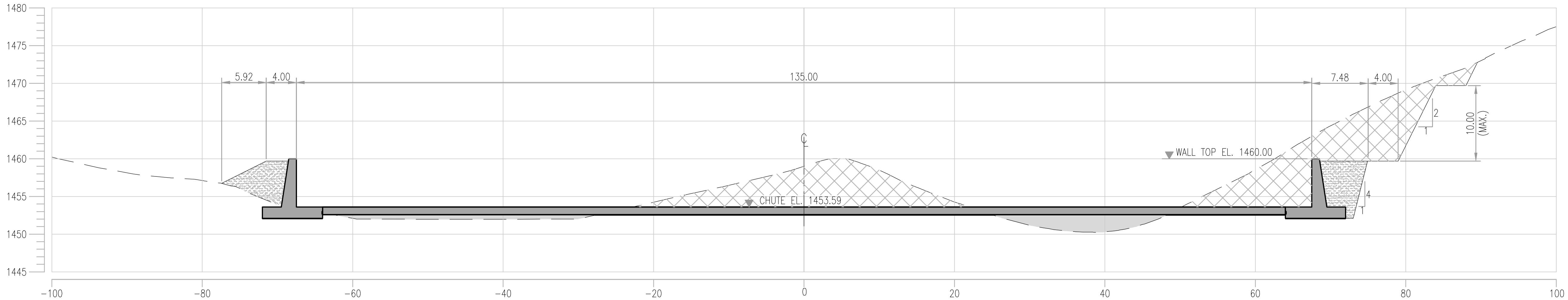
CLIENT : ADB ASIAN DEVELOPMENT BANK	CONSULTANT: Techno-Consult International (Pvt.)Ltd.	PROJECT: BALOCHISTAN WATER RESOURCES DEVELOPMENT PROJECT (TA) SCHEME: SIRI TOI DAM ZHOB RIVER BASIN	DRAWING TITLE : SPILLWAY CROSS SECTIONS AT STA: -0+030, -0+020 & -0+010	Designed By : ABDUL HAI Drawn By : ARSALAN RAFAT Checked By : ZAFAR MASOOD SIDDIQUE Approved By : DR BASHIR LAKHANI

Date :	NOVEMBER 2017
Scale :	AS SHOWN
Drg No :	BWRDP-ZRB-STD-SP-361

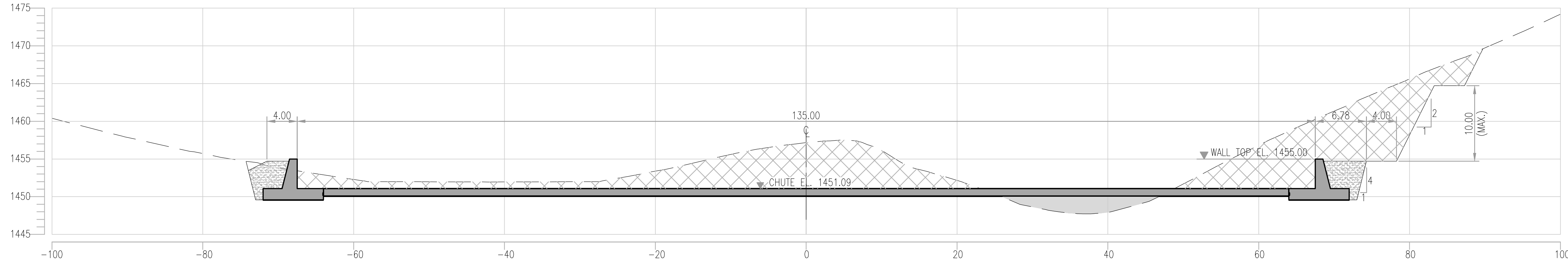
No.	Revision	By	Date



CROSS SECTION AT STA: 0+000



CROSS SECTION AT STA: 0+010



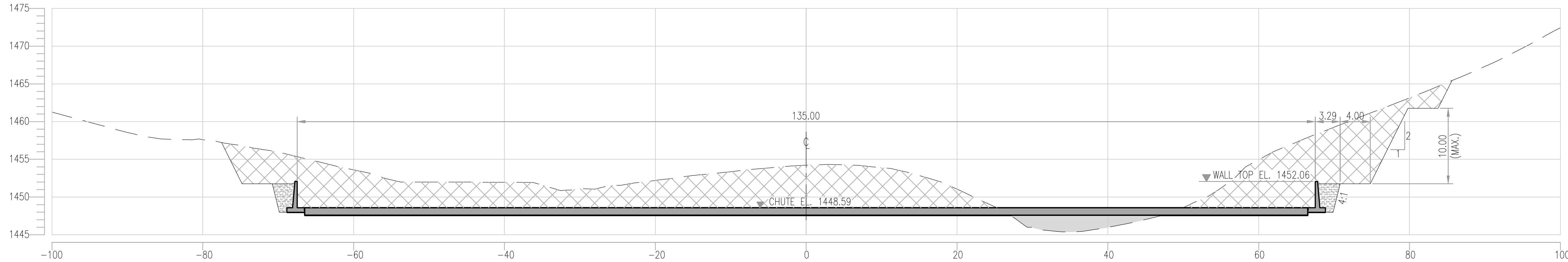
CROSS SECTION AT STA: 0+020

SCALE:-
0 5 10 15 20 25
m

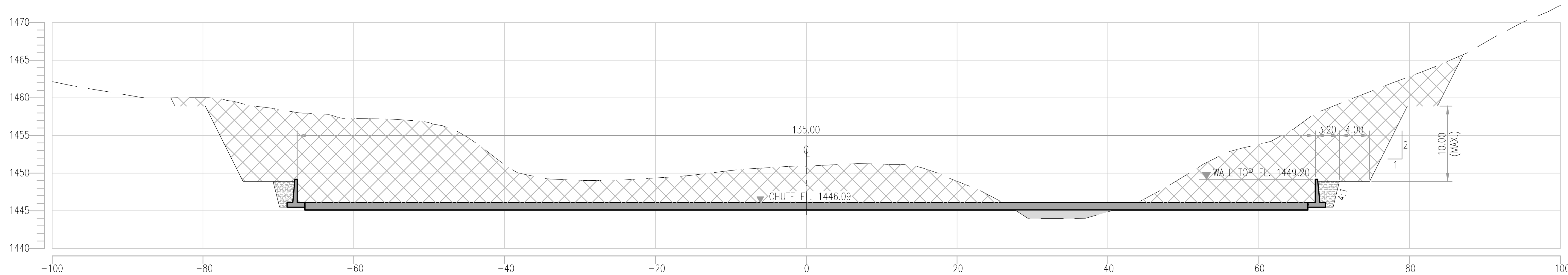
NOTE:
1. ALL DIMENSIONS & LEVELS ARE IN METER.

CLIENT : ADB ASIAN DEVELOPMENT BANK	CONSULTANT: Techno-Consult International (Pvt.)Ltd.	PROJECT: BALOCHISTAN WATER RESOURCES DEVELOPMENT PROJECT (TA)	DRAWING TITLE : SPILLWAY CROSS SECTIONS AT STA: 0+000, 0+010 & 0+020	Designed By : ABDUL HAI	Date : NOVEMBER 2017	
		SCHEME: SIRI TOI DAM ZHOB RIVER BASIN		Drawn By : ARSALAN RAFAT	Scale : AS SHOWN	
				Checked By : ZAFAR MASOOD SIDDIQUE	Drg No : BWRDP-ZRB-STD-SP-362	
				Approved By : DR BASHIR LAKHANI		

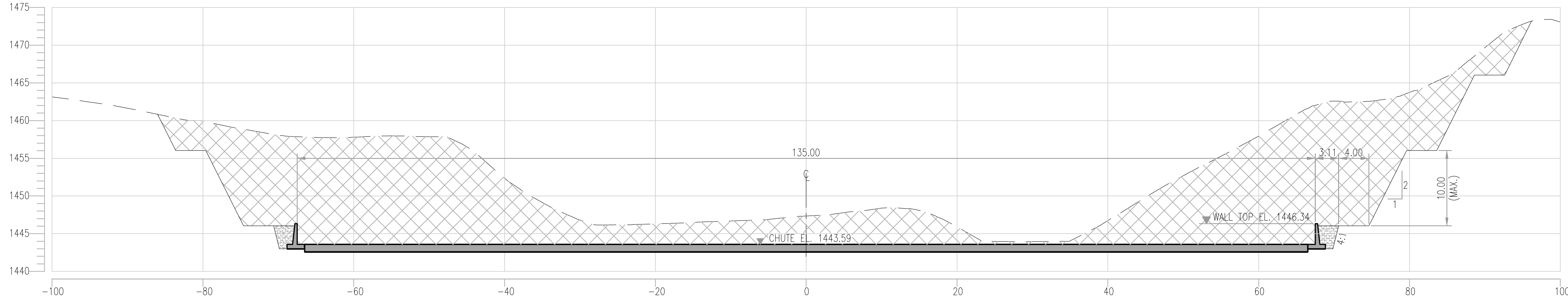
No.	Revision	By	Date



CROSS SECTION AT STA: 0+030



CROSS SECTION AT STA: 0+040



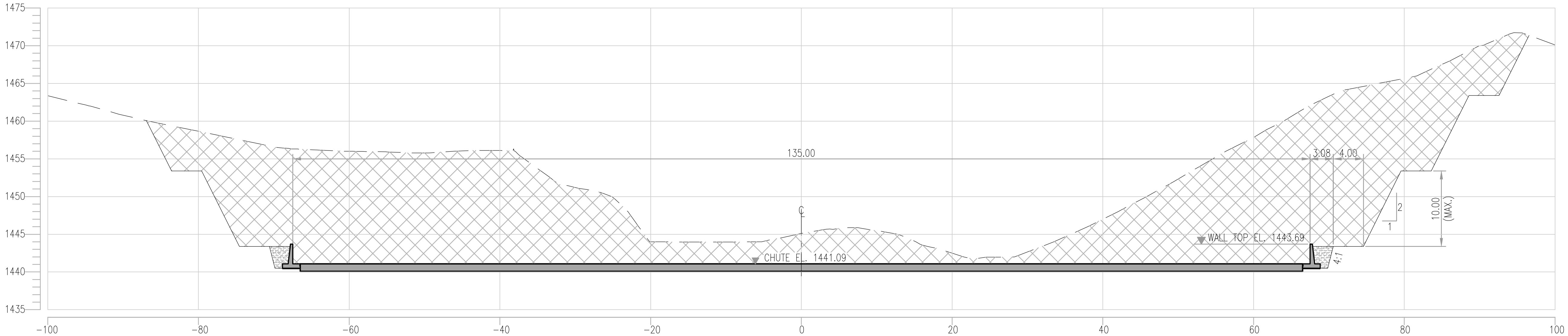
CROSS SECTION AT STA: 0+050

SCALE:-
0 5 10 15 20 25
m

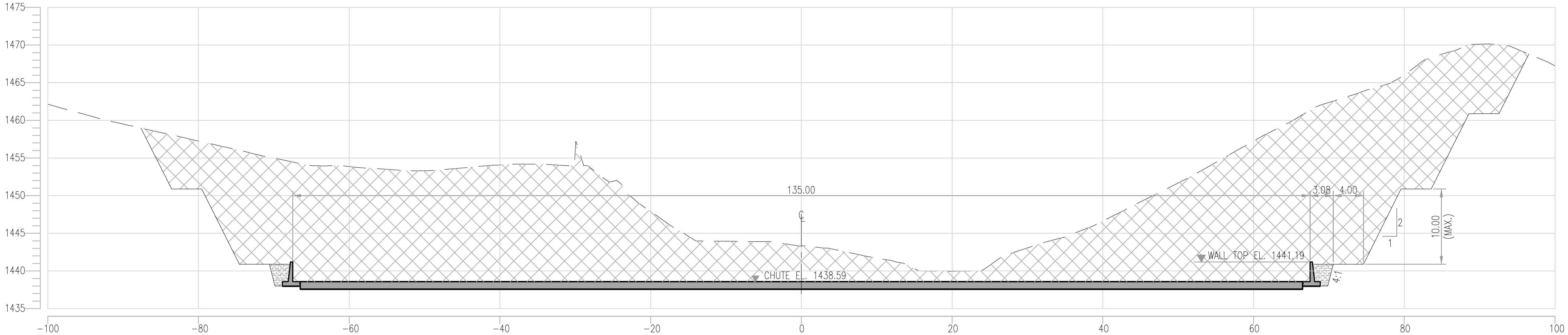
NOTE:
1. ALL DIMENSIONS & LEVELS ARE IN METER.

CLIENT :	CONSULTANT:	PROJECT:	DRAWING TITLE :		
ASIAN DEVELOPMENT BANK	Techno-Consult International (Pvt.)Ltd.	BALOCHISTAN WATER RESOURCES DEVELOPMENT PROJECT (TA)	SPILLWAY CROSS SECTIONS AT STA: 0+030, 0+040 & 0+050	Designed By : ABDUL HAI	Date : NOVEMBER 2017
		SCHEME: SIRI TOI DAM ZHOB RIVER BASIN		Drawn By : ARSALAN RAFAT	Scale : AS SHOWN
				Checked By : ZAFAR MASOOD SIDDIQUE	Drg No :
				Approved By : DR BASHIR LAKHANI	BWRDP-ZRB-STD-SP-363

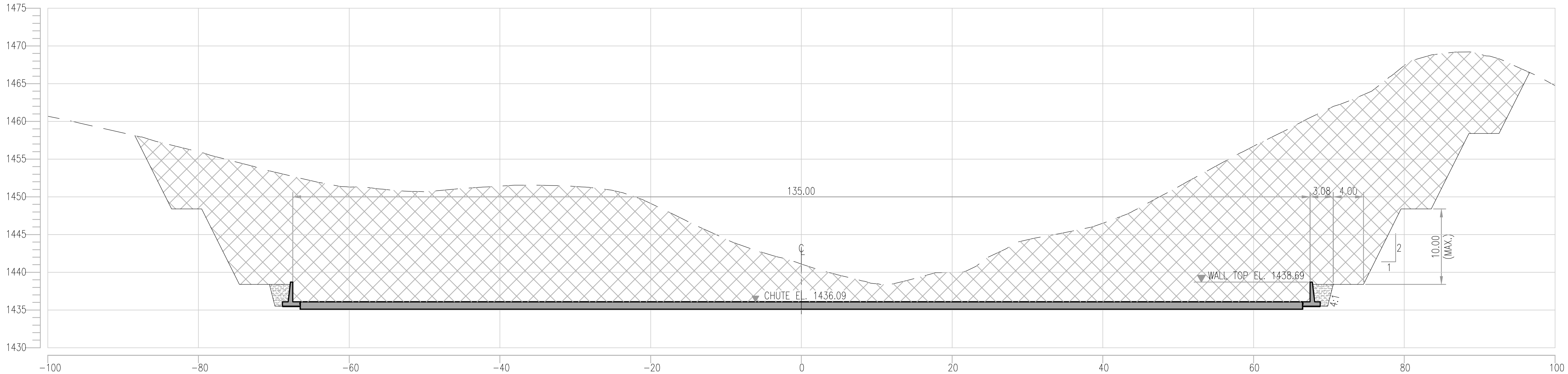
No.	Revision	By	Date



CROSS SECTION AT STA: 0+060



CROSS SECTION AT STA: 0+070



CROSS SECTION AT STA: 0+080

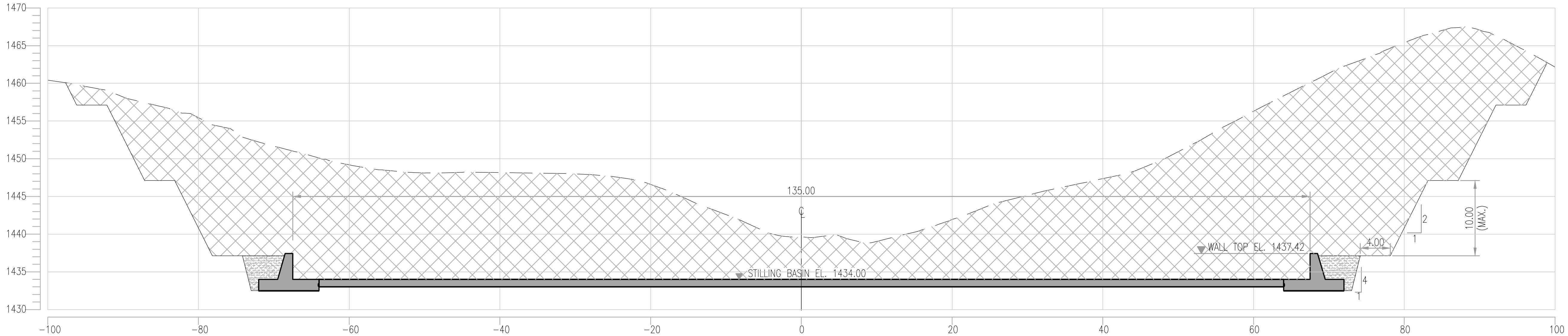
SCALE:- 0 5 10 15 20 25 m

NOTE:

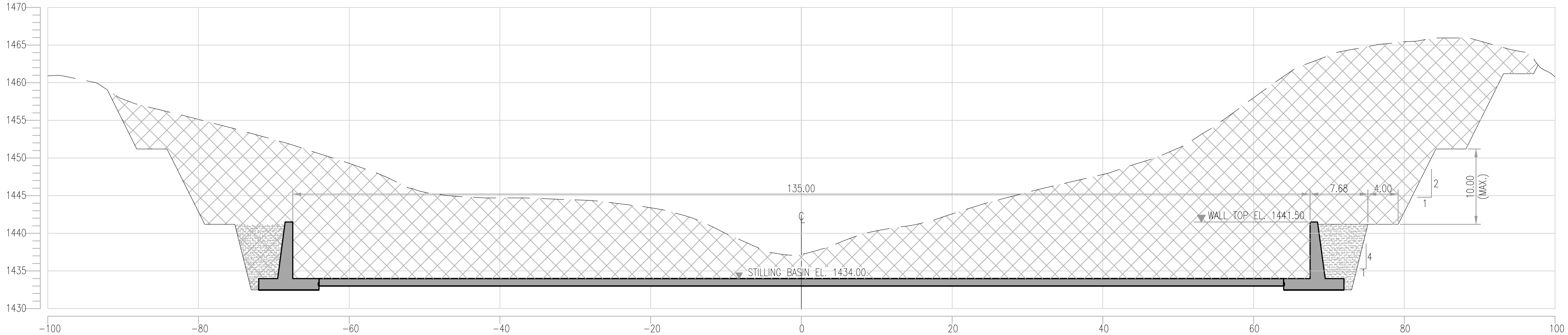
1. ALL DIMENSIONS & LEVELS ARE IN METER.

CLIENT :	CONSULTANT:	PROJECT:	DRAWING TITLE :				
ASIAN DEVELOPMENT BANK	Techno-Consult International (Pvt.)Ltd.	BALOCHISTAN WATER RESOURCES DEVELOPMENT PROJECT (TA)	SPILLWAY CROSS SECTIONS AT STA: 0+060, 0+070 & 0+080	Designed By : ABDUL HAI	Date : NOVEMBER 2017		
		SCHEME: SIRI TOI DAM ZHOB RIVER BASIN		Drawn By : ARSALAN RAFAT	Scale : AS SHOWN		
				Checked By : ZAFAR MASOOD SIDDIQUE	Drg No :		
				Approved By : DR BASHIR LAKHANI	BWRDP-ZRB-STD-SP-364		

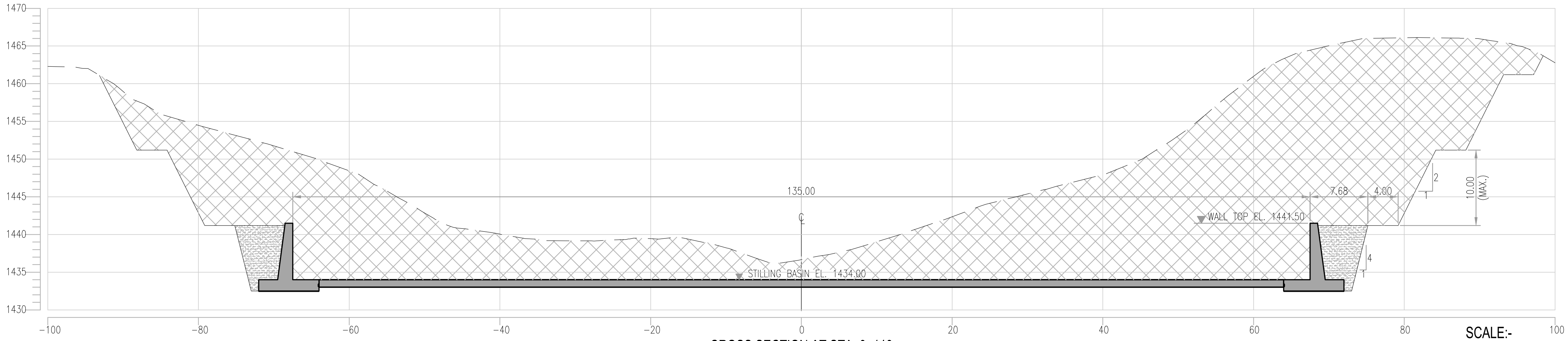
No.	Revision	By	Date



CROSS SECTION AT STA: 0+090



CROSS SECTION AT STA: 0+100



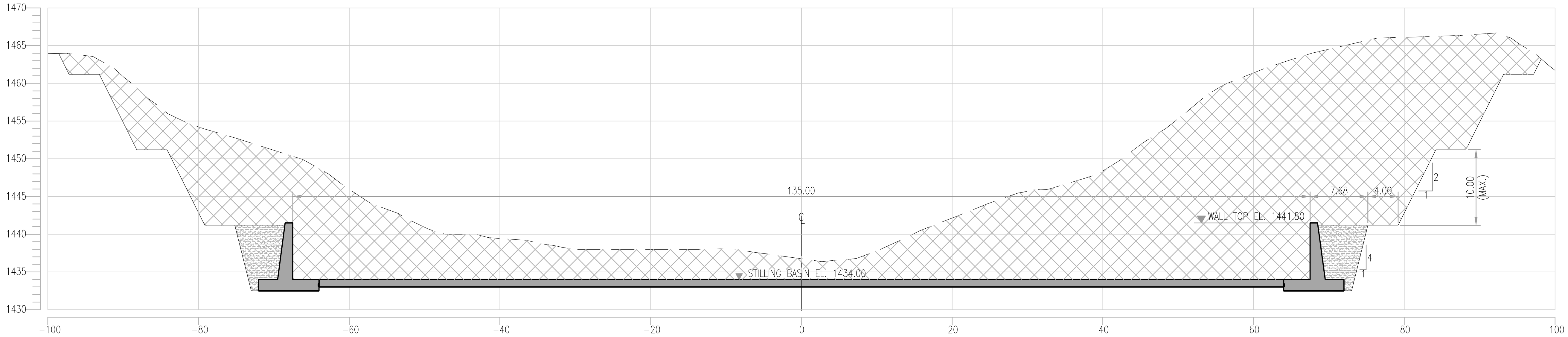
CROSS SECTION AT STA: 0+110

SCALE:-
0 5 10 15 20 25
m

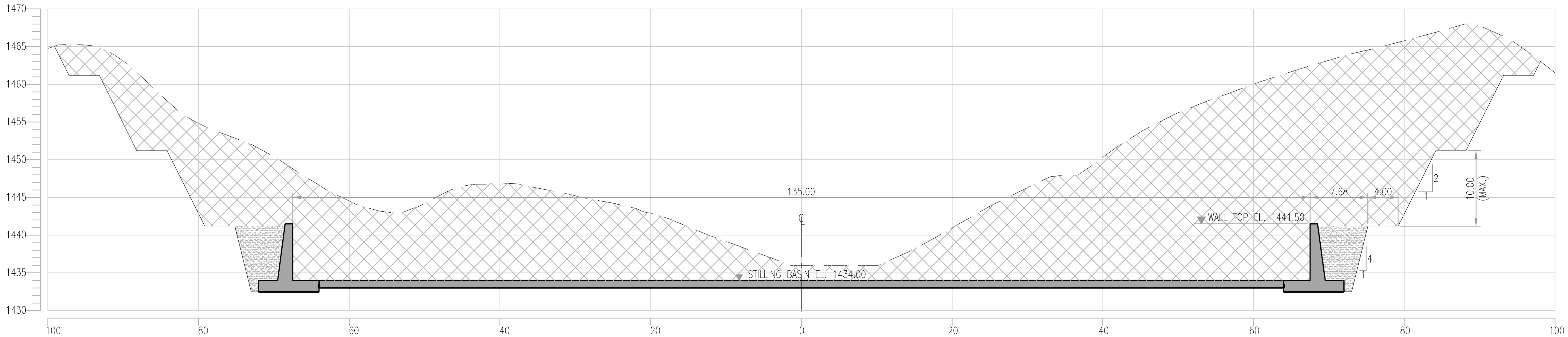
NOTE:
1. ALL DIMENSIONS & LEVELS ARE IN METER.

CLIENT : ADB ASIAN DEVELOPMENT BANK	CONSULTANT: Techno-Consult International (Pvt.)Ltd.	PROJECT: BALOCHISTAN WATER RESOURCES DEVELOPMENT PROJECT (TA)	DRAWING TITLE : SPILLWAY CROSS SECTIONS AT STA: 0+090, 0+100 & 0+110	Designed By : ABDUL HAI	Date : NOVEMBER 2017
		SCHEME: SIRI TOI DAM ZHOB RIVER BASIN		Drawn By : ARSALAN RAFAT	Scale : AS SHOWN
				Checked By : ZAFAR MASOOD SIDDIQUE	Drg No :
				Approved By : DR BASHIR LAKHANI	BWRDP-ZRB-STD-SP-365

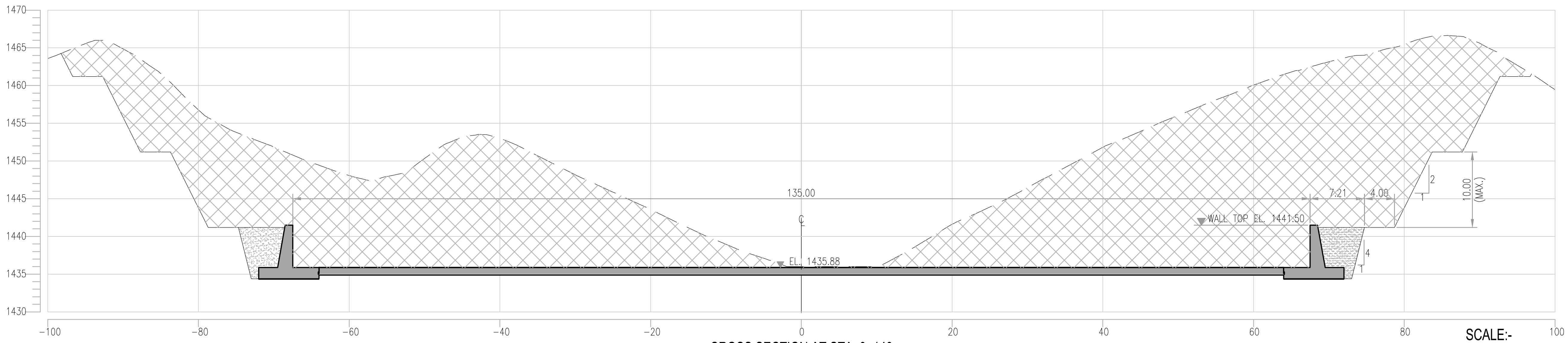
No.	Revision	By	Date



CROSS SECTION AT STA: 0+120



CROSS SECTION AT STA: 0+130



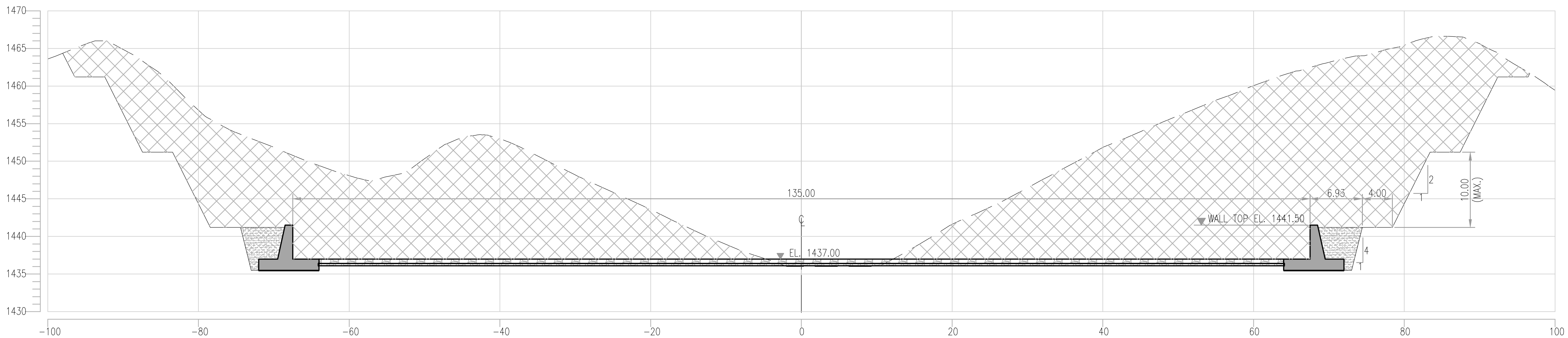
CROSS SECTION AT STA: 0+140

SCALE:-
0 5 10 15 20 25
m

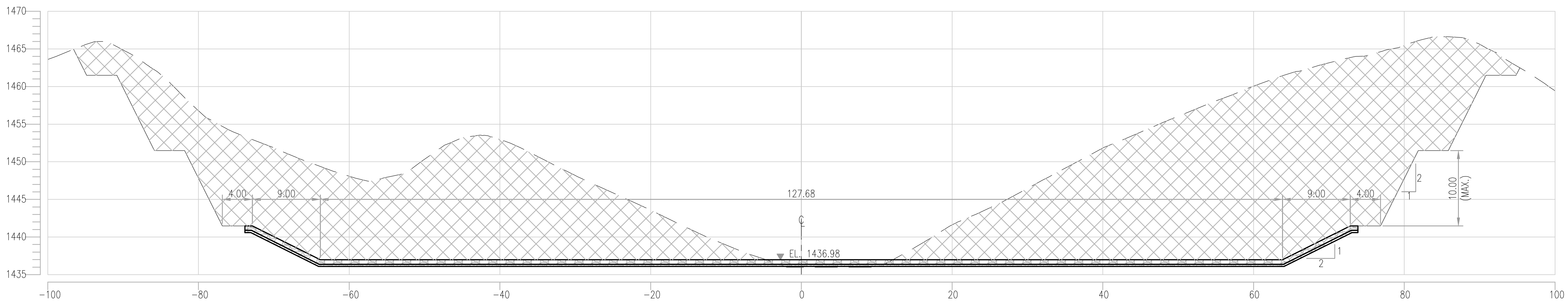
NOTE:
1. ALL DIMENSIONS & LEVELS ARE IN METER.

CLIENT : ADB ASIAN DEVELOPMENT BANK	CONSULTANT: Techno-Consult International (Pvt.) Ltd.	PROJECT: BALOCHISTAN WATER RESOURCES DEVELOPMENT PROJECT (TA) SCHEME: SIRI TOI DAM ZHOB RIVER BASIN	DRAWING TITLE : SPILLWAY CROSS SECTIONS AT STA: 0+120, 0+130 & 0+140	Designed By : ABDUL HAI Drawn By : ARSALAN RAFAT Checked By : ZAFAR MASOOD SIDDIQUE Approved By : DR BASHIR LAKHANI	Date : NOVEMBER 2017 Scale : AS SHOWN Drg No : BWRDP-ZRB-STD-SP-366

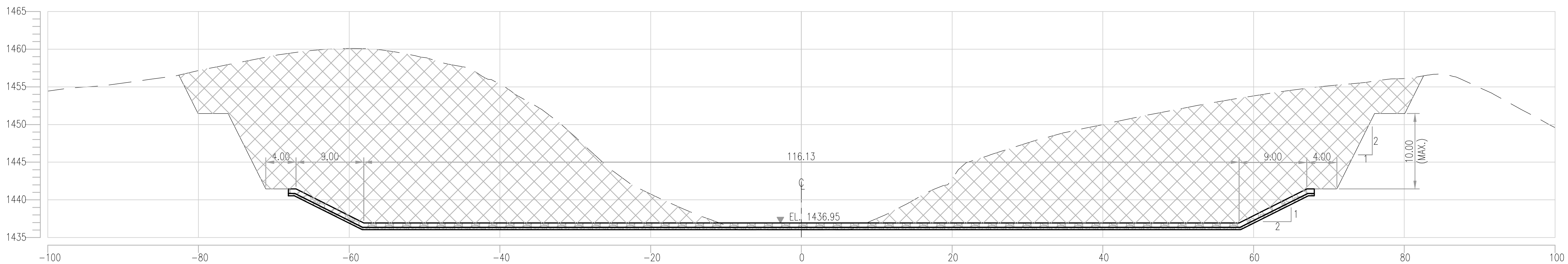
No.	Revision	By	Date



CROSS SECTION AT STA: 0+150



CROSS SECTION AT STA: 0+160



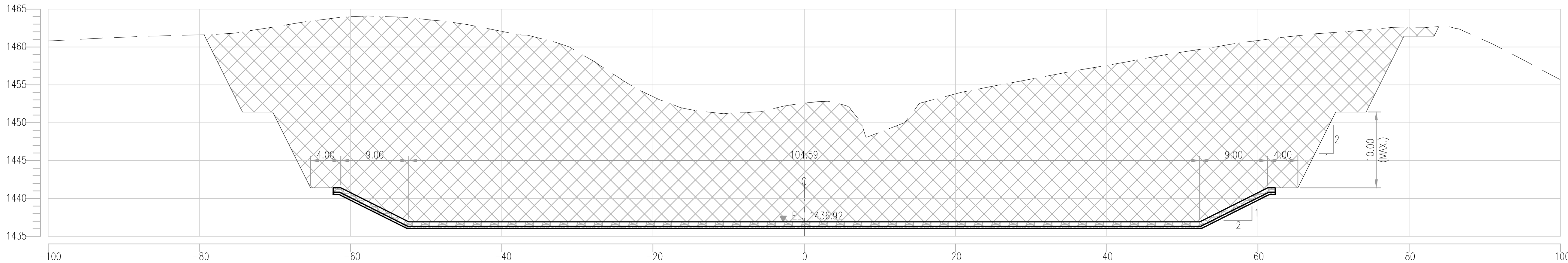
CROSS SECTION AT STA: 0+170

SCALE:-
0 5 10 15 20 25
m

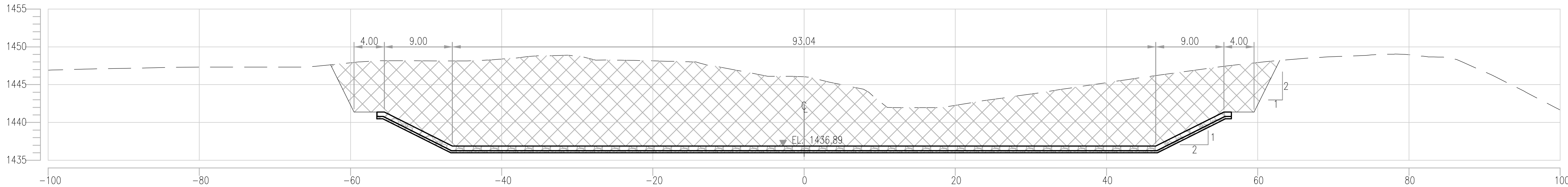
NOTE:
1. ALL DIMENSIONS & LEVELS ARE IN METER.

CLIENT :	CONSULTANT:	PROJECT:	DRAWING TITLE :		
ADB ASIAN DEVELOPMENT BANK	Techno-Consult International (Pvt.)Ltd.	BALOCHISTAN WATER RESOURCES DEVELOPMENT PROJECT (TA)	SPILLWAY CROSS SECTIONS AT STA: 0+150, 0+160 & 0+170	Designed By : ABDUL HAI	Date : NOVEMBER 2017
		SCHEME: SIRI TOI DAM ZHOB RIVER BASIN		Drawn By : ARSALAN RAFAT	Scale : AS SHOWN
				Checked By : ZAFAR MASOOD SIDDIQUE	Drg No :
				Approved By : DR BASHIR LAKHANI	BWRDP-ZRB-STD-SP-367

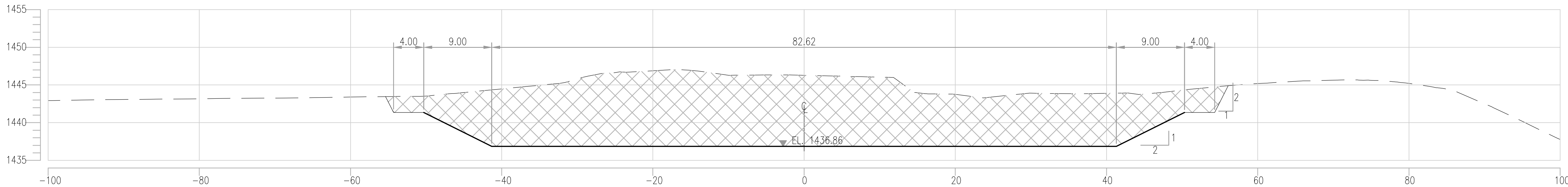
No.	Revision	By	Date



CROSS SECTION AT STA: 0+180



CROSS SECTION AT STA: 0+190

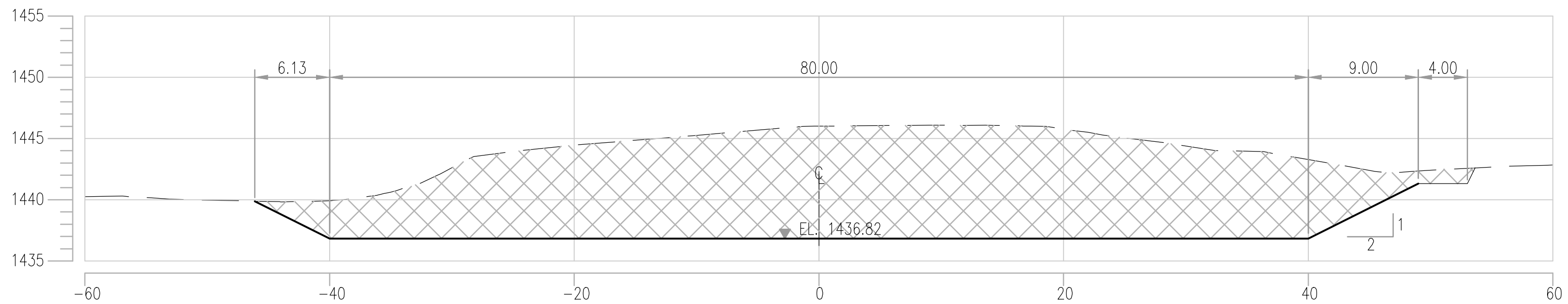


CROSS SECTION AT STA: 0+200

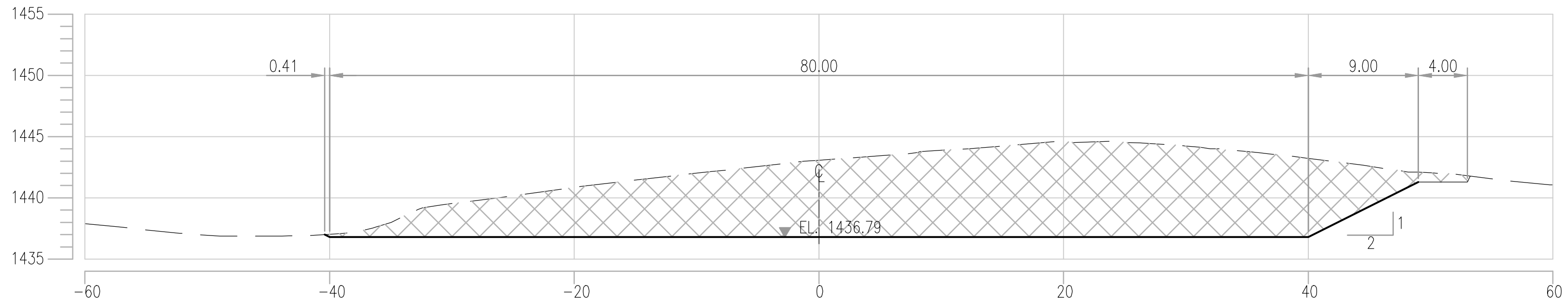
SCALE:-
0 5 10 15 20 25
m

NOTE:
1. ALL DIMENSIONS & LEVELS ARE IN METER.

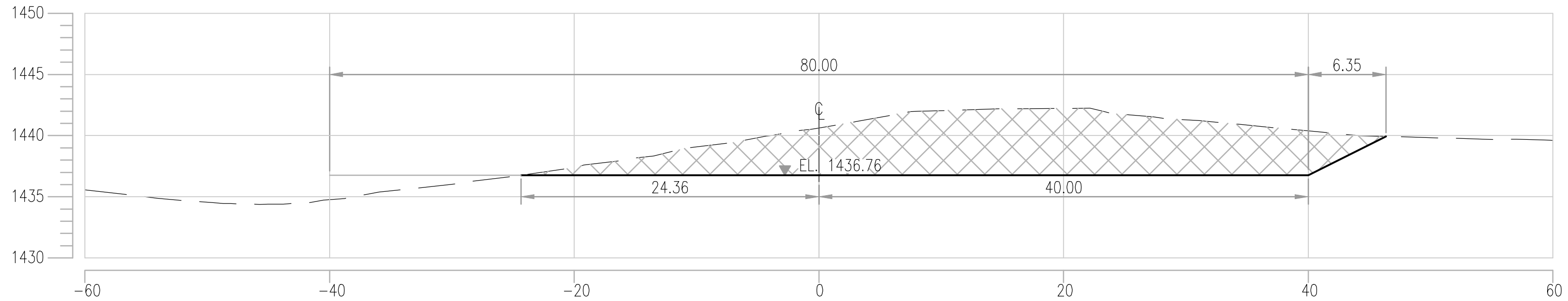
CLIENT : ADB ASIAN DEVELOPMENT BANK	CONSULTANT: Techno-Consult International (Pvt.)Ltd.	PROJECT: BALOCHISTAN WATER RESOURCES DEVELOPMENT PROJECT (TA)	DRAWING TITLE : SPILLWAY CROSS SECTIONS AT STA: 0+180, 0+190 & 0+200	Designed By : ABDUL HAI	Date : NOVEMBER 2017	No. / Revision / By / Date
		SCHEME: SIRI TOI DAM ZHOB RIVER BASIN		Drawn By : ARSALAN RAFAT	Scale : AS SHOWN	
				Checked By : ZAFAR MASOOD SIDDIQUE	Drg No :	
				Approved By : DR BASHIR LAKHANI	BWRDP-ZRB-STD-SP-368	



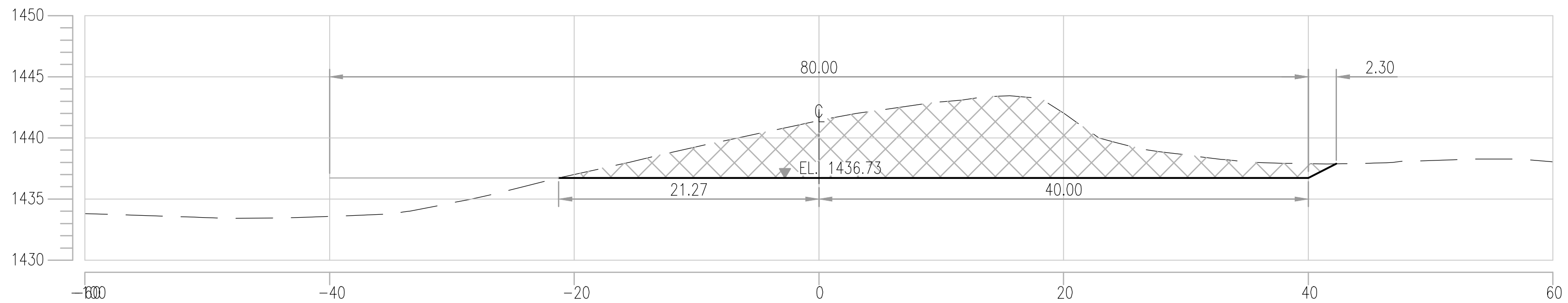
CROSS SECTION AT STA: 0+210



CROSS SECTION AT STA: 0+220



CROSS SECTION AT STA: 0+230



CROSS SECTION AT STA: 0+240

SCALE:-

0 5 10 15 20 25

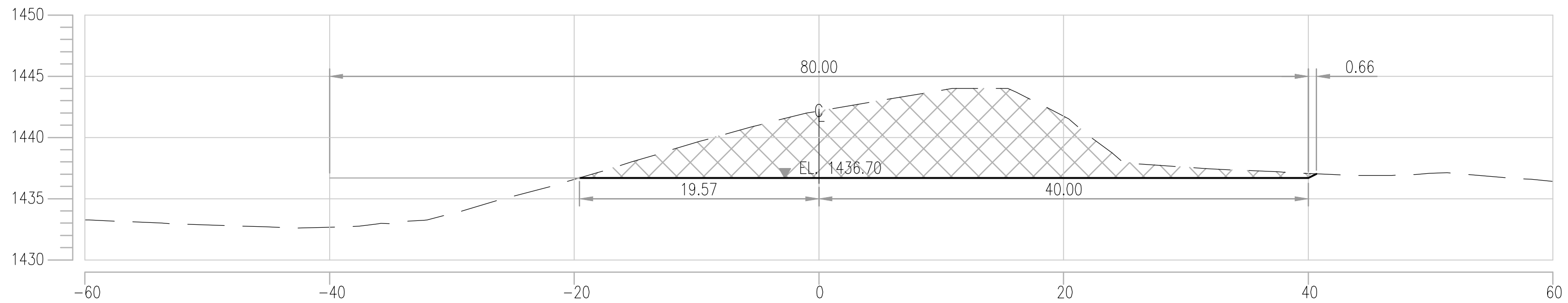
m

NOTE:

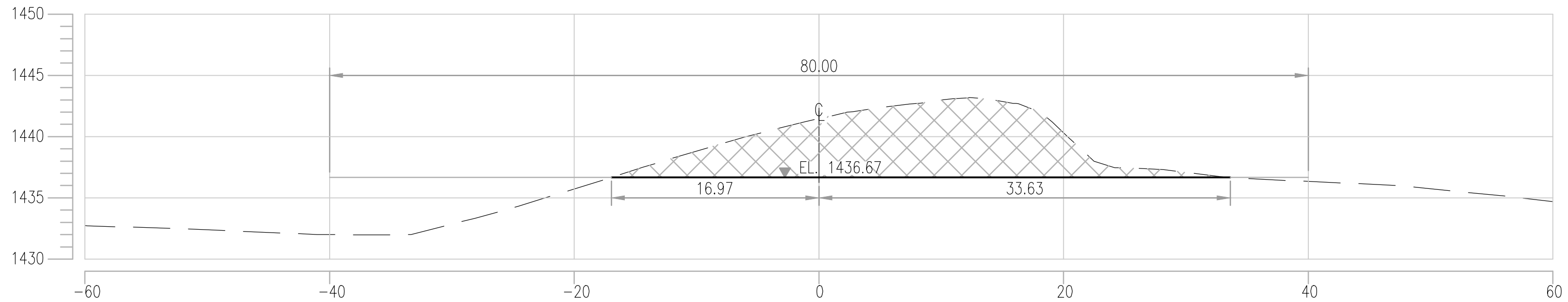
1. ALL DIMENSIONS & LEVELS ARE IN METER.

CLIENT : ADB ASIAN DEVELOPMENT BANK	CONSULTANT: Techno-Consult International (Pvt.)Ltd.	PROJECT: BALOCHISTAN WATER RESOURCES DEVELOPMENT PROJECT (TA)	DRAWING TITLE : SPILLWAY CROSS SECTIONS AT STA: 0+210, 0+220, 0+230 & 0+240	Designed By : ABDUL HAI	Date : NOVEMBER 2017
		SCHEME: SIRI TOI DAM ZHOB RIVER BASIN		Drawn By : ARSALAN RAFAT	Scale : AS SHOWN
				Checked By : ZAFAR MASOOD SIDDIQUE	Drg No :
				Approved By : DR BASHIR LAKHANI	BWRDP-ZRB-STD-SP-369

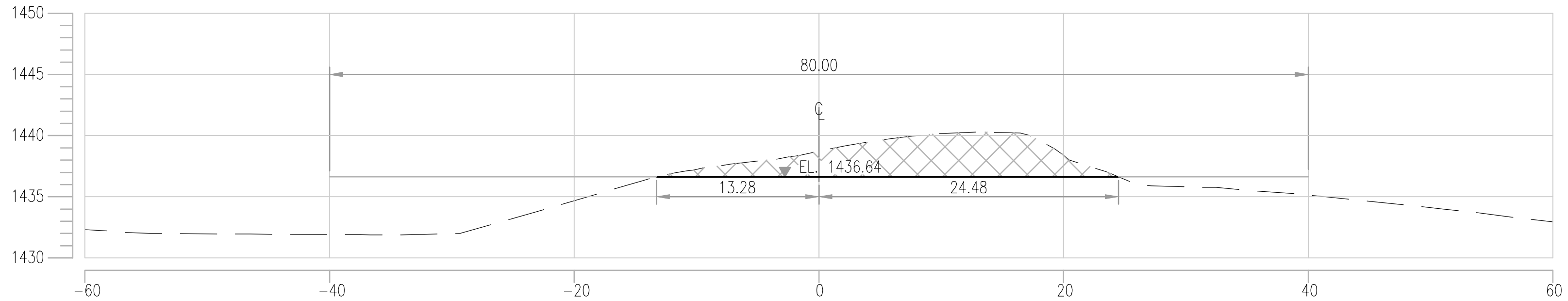
No.	Revision	By	Date



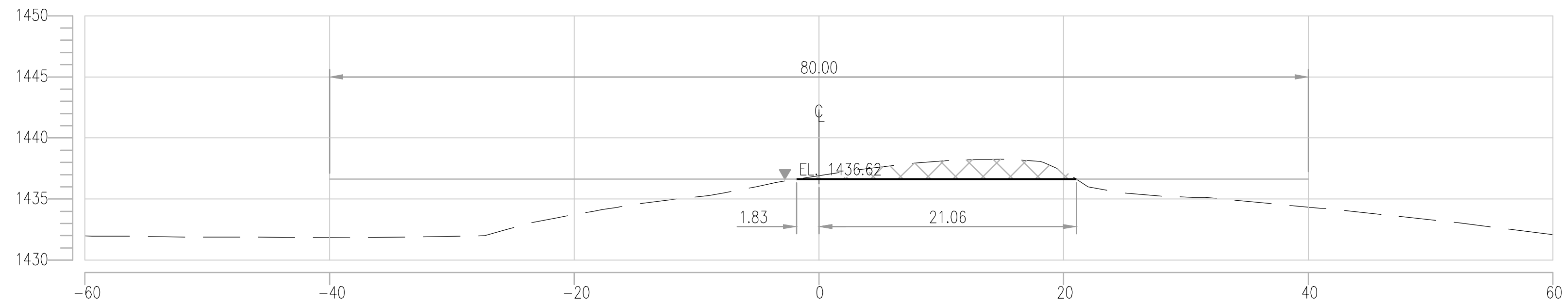
CROSS SECTION AT STA: 0+250



CROSS SECTION AT STA: 0+260



CROSS SECTION AT STA: 0+270



CROSS SECTION AT STA: 0+275

SCALE:-
0 5 10 15 20 25
m

NOTE:
1. ALL DIMENSIONS & LEVELS ARE IN METER.

CLIENT : ASIAN DEVELOPMENT BANK	CONSULTANT: Techno-Consult International (Pvt.)Ltd.	PROJECT: BALOCHISTAN WATER RESOURCES DEVELOPMENT PROJECT (TA)	DRAWING TITLE : SPILLWAY CROSS SECTIONS AT STA: 0+250, 0+260, 0+270 & 0+275	Designed By : ABDUL HAI	Date : NOVEMBER 2017
		SCHEME: SIRI TOI DAM ZHOB RIVER BASIN		Drawn By : ARSALAN RAFAT	Scale : AS SHOWN
				Checked By : ZAFAR MASOOD SIDDIQUE	Drg No :
				Approved By : DR BASHIR LAKHANI	BWRDP-ZRB-STD-SP-370

No.	Revision	By	Date

SIRI TOI DAM

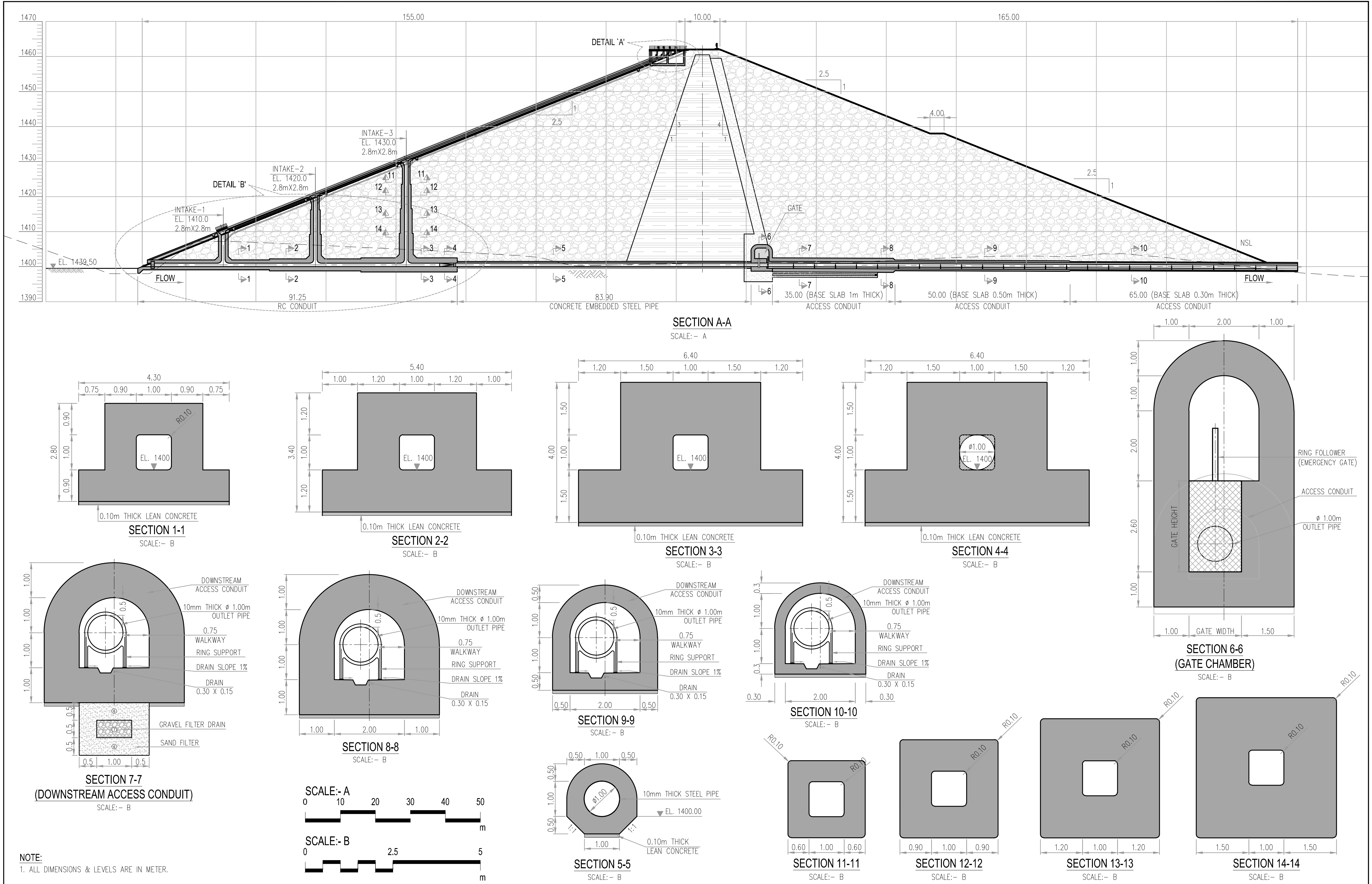
INTAKE STRUCTURE
ACCESS CONDUIT
STEEL PIPE
&
OUTLET WORKS

NOTE:
1. ALL STATIONS & LEVELS ARE IN METERS.

SCALE:
0 25 50
m

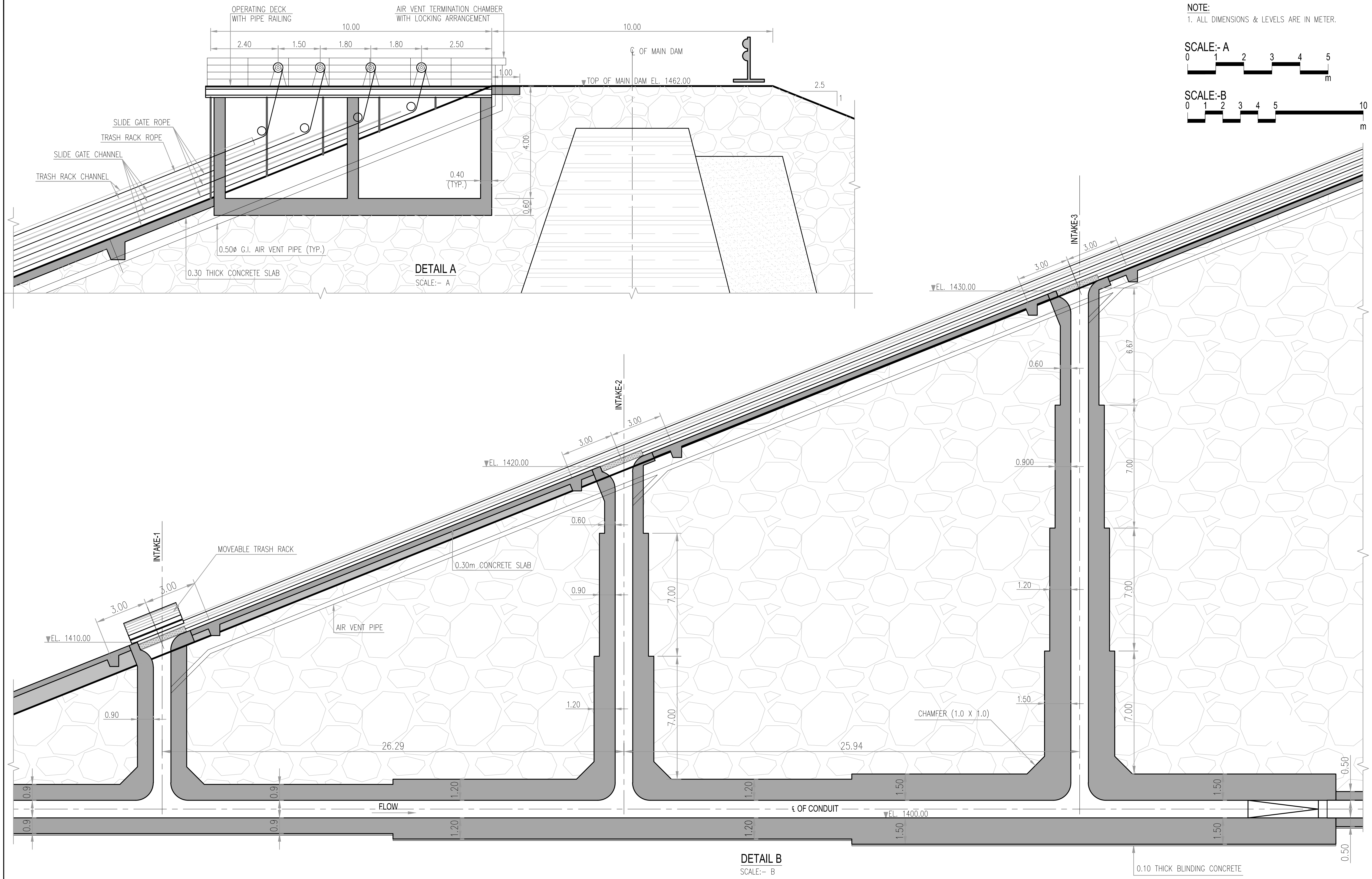
CLIENT :	CONSULTANT :	PROJECT:	DRAWING TITLE :		
ADB ASIAN DEVELOPMENT BANK	Techno-Consult International (Pvt.)Ltd.	BALOCHISTAN WATER RESOURCES DEVELOPMENT PROJECT (TA)	INTAKE STRUCTURE & OUTLET WORKS LAYOUT PLAN	Designed By : ABDUL HAI	Date : NOVEMBER 2017
		SCHEME:		Drawn By : ARSALAN RAFAT	Scale : AS SHOWN
		SIRI TOI DAM ZHOB RIVER BASIN		Checked By : ZAFAR MASOOD SIDDIQUE	Drg No :
				Approved By : DR BASHIR LAKHANI	BWRDP-ZRB-STD-OW-401

No.	Revision	By	Date



CLIENT :	CONSULTANT :	PROJECT:	DRAWING TITLE :				
ADB ASIAN DEVELOPMENT BANK	Techno-Consult International (Pvt.) Ltd.	BALOCHISTAN WATER RESOURCES DEVELOPMENT PROJECT (TA)	INTAKE STRUCTURE & OUTLET WORKS LONGITUDINAL SECTION (IN MAIN DAM) & DETAILS	Designed By : ABDUL HAI	Date : NOVEMBER 2017	No.	Revision	By	Date
		SCHEME: SIRI TOI DAM ZHOB RIVER BASIN		Drawn By : ARSALAN RAFAT	Scale : AS SHOWN				
				Checked By : ZAFAR MASOOD SIDDIQUE	Drg No :				
				Approved By : DR BASHIR LAKHANI	BWRDP-ZRB-STD-OW-402				

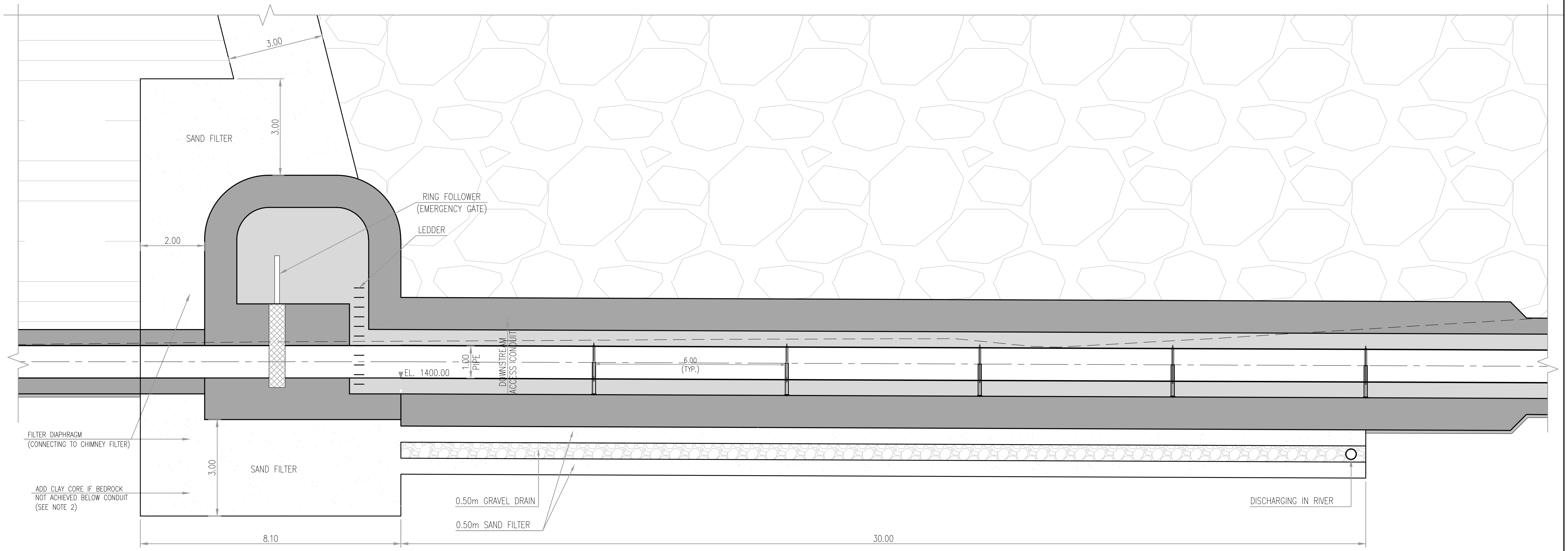
NOTE:
1. ALL DIMENSIONS & LEVELS ARE IN METER.



CLIENT :	CONSULTANT :	PROJECT:	DRAWING TITLE :					No.	Revision	By	Date
ADB ASIAN DEVELOPMENT BANK	Techno-Consult International (Pvt.)Ltd.	BALOCHISTAN WATER RESOURCES DEVELOPMENT PROJECT (TA)	INTAKE STRUCTURE DETAILS A & B	Designed By :	ABDUL HAI	Date :	NOVEMBER 2017				
				Drawn By :	ARSALAN RAFAT	Scale :	AS SHOWN				
		SCHEME: SIRI TOI DAM ZHOB RIVER BASIN		Checked By :	ZAFAR MASOOD SIDDIQUE	Drg No :					
				Approved By :	DR BASHIR LAKHANI		BWRDP-ZRB-STD-OW-403				

NOTES:

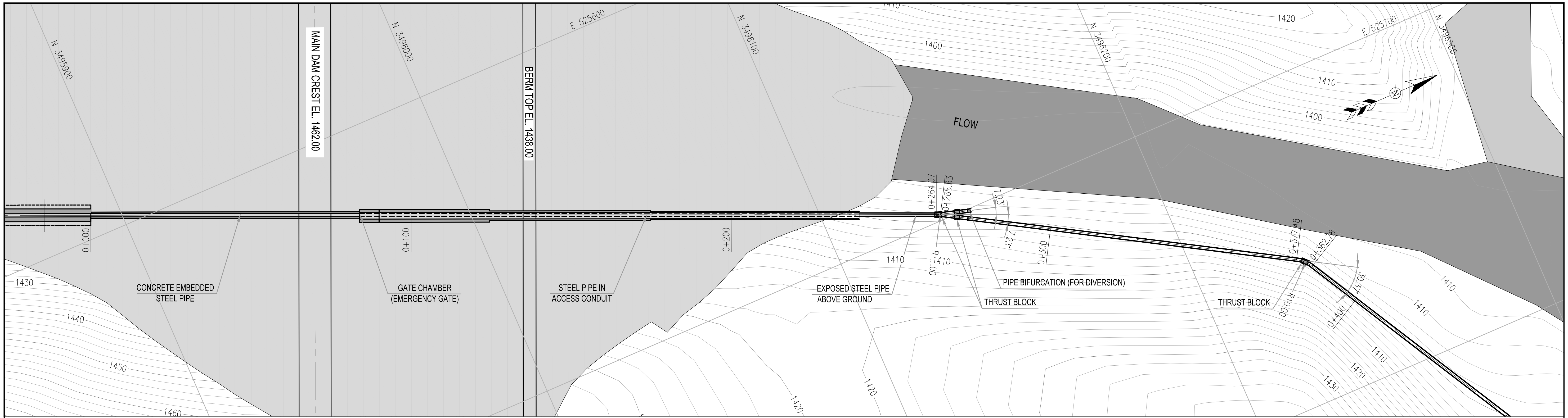
1. ALL DIMENSIONS AND LEVELS ARE IN METERS.
2. PROVIDE CLAY CORE BELOW PIPE IF BED ROCK IS NOT ACHIEVED AFTER CONSULTATION OF SITE ENGINEER.

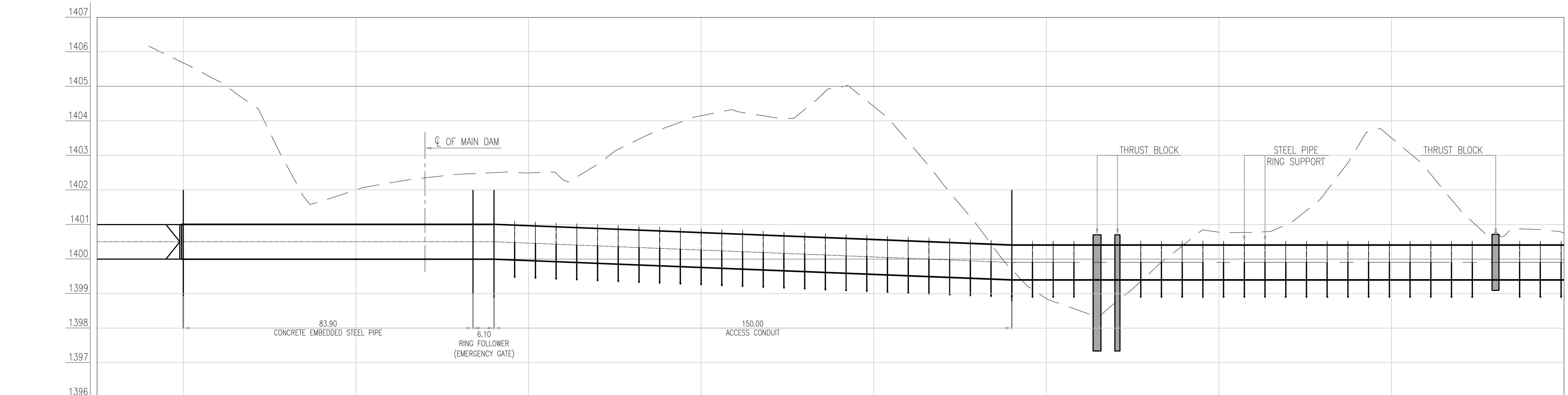


FILTER ARRANGEMENT

SCALE:-
0 1 2 3 4 5
m

CLIENT :	CONSULTANT :	PROJECT:	DRAWING TITLE :					No.	Revision	By	Date
ADB ASIAN DEVELOPMENT BANK	Techno-Consult International (Pvt.)Ltd.	BALOCHISTAN WATER RESOURCES DEVELOPMENT PROJECT (TA)	OUTLET WORKS FILTER ARRANGEMENT & GATE CHAMBER	Designed By :	ABDUL HAI	Date :	NOVEMBER 2017				
				Drawn By :	ARSALAN RAFAT	Scale :	AS SHOWN				
		SCHEME: SIRI TOI DAM ZHOB RIVER BASIN		Checked By :	ZAFAR MASOOD SIDDIQUE	Drg No :					
				Approved By :	DR BASHIR LAKHANI		BWRDP-ZRB-STD-OW-404				





PIPE INVERT LEVEL m	1400.000	1400.000	1400.000	1399.960	1399.760	1399.560	1399.400	1399.400	1399.400	1399.400
NATURAL SURFACE LEVEL m	1406.164	1405.681	1402.001	1402.496	1404.149	1404.423	1398.858	1400.777	1403.507	1400.752
DISTANCE m	-0+025	0+000	0+050	0+100	0+150	0+200	0+250	0+300	0+350	0+400

PROFILE VERTICAL SCALE:

0 2.5 5 7.5 10 m

HORIZONTAL SCALE:

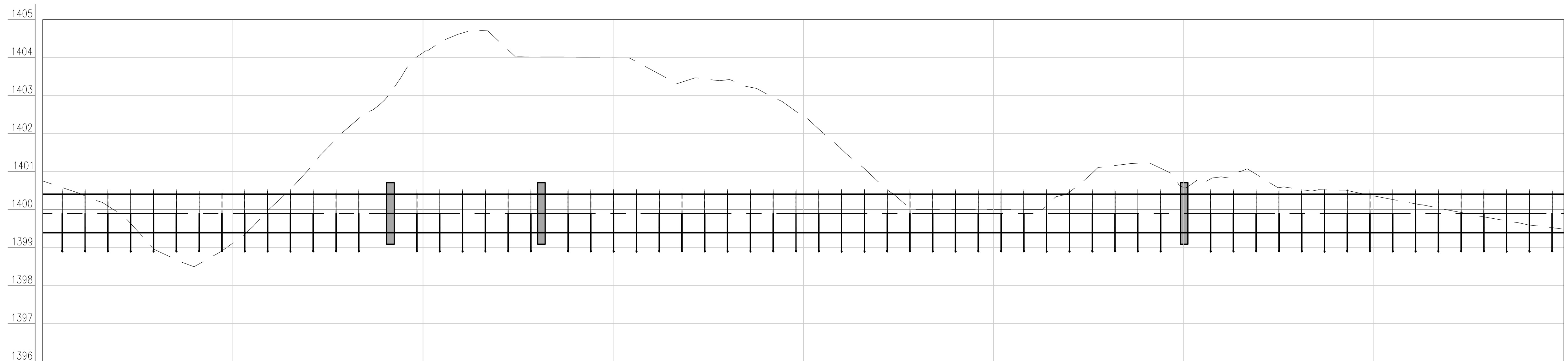
0 25 50 75 100 m

NOTE:

1. ALL DIMENSIONS, STATIONS & LEVELS ARE IN METER.

CLIENT : ADB ASIAN DEVELOPMENT BANK	CONSULTANT : Techno-Consult International (Pvt.)Ltd.	PROJECT: BALOCHISTAN WATER RESOURCES DEVELOPMENT PROJECT (TA)	DRAWING TITLE : STEEL PIPE PLAN & PROFILE STA: AT 0+000 TO 0+400	Designed By : ABDUL HAI	Date : NOVEMBER 2017
		SCHEME: SIRI TOI DAM ZHOB RIVER BASIN		Drawn By : ARSALAN RAFAT	Scale : AS SHOWN
				Checked By : ZAFAR MASOOD SIDDIQUE	Drg No : BWRDP-ZRB-STD-OW-405
				Approved By : DR BASHIR LAKHANI	

No.	Revision	By	Date



PIPE INVERT LEVEL m	1399.400	1399.400	1399.400	1399.400	1399.400	1399.400	1399.400	1399.400	1399.400
NATURAL SURFACE LEVEL m	1400.752	1399.123	1404.130	1403.997	1402.460	1400.000	1400.581	1400.361	1399.485
DISTANCE m	0+400	0+450	0+500	0+550	0+600	0+650	0+700	0+750	0+800

PROFILE VERTICAL SCALE:

0 2.5 5 7.5 10 m

HORIZONTAL SCALE:

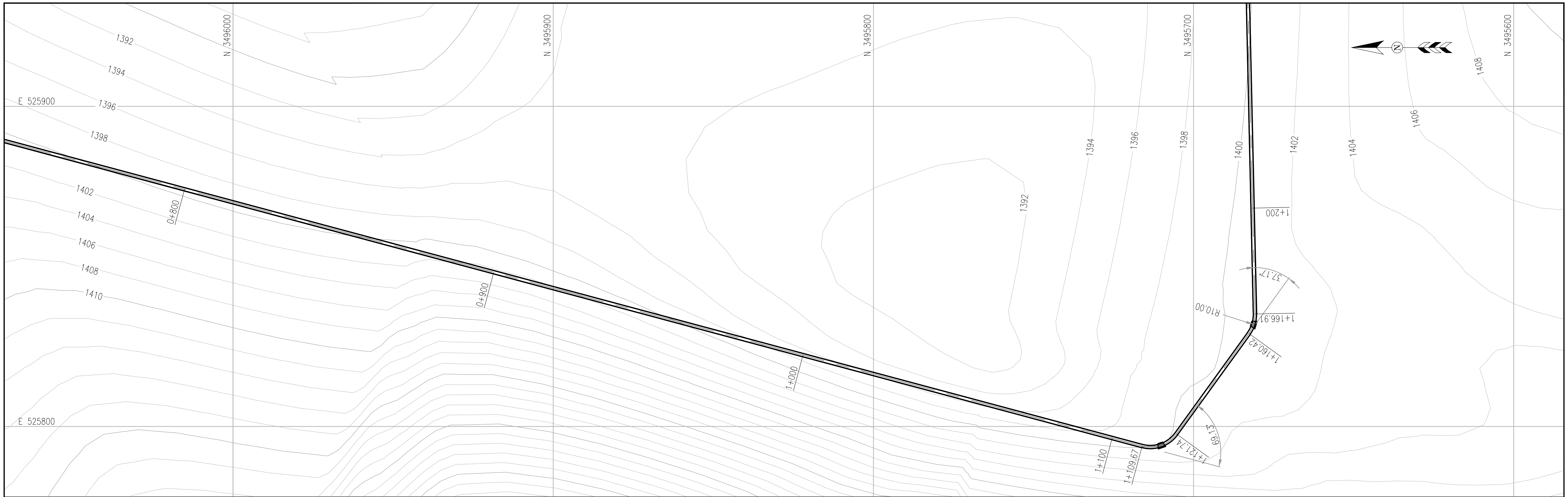
0 25 50 75 100 m

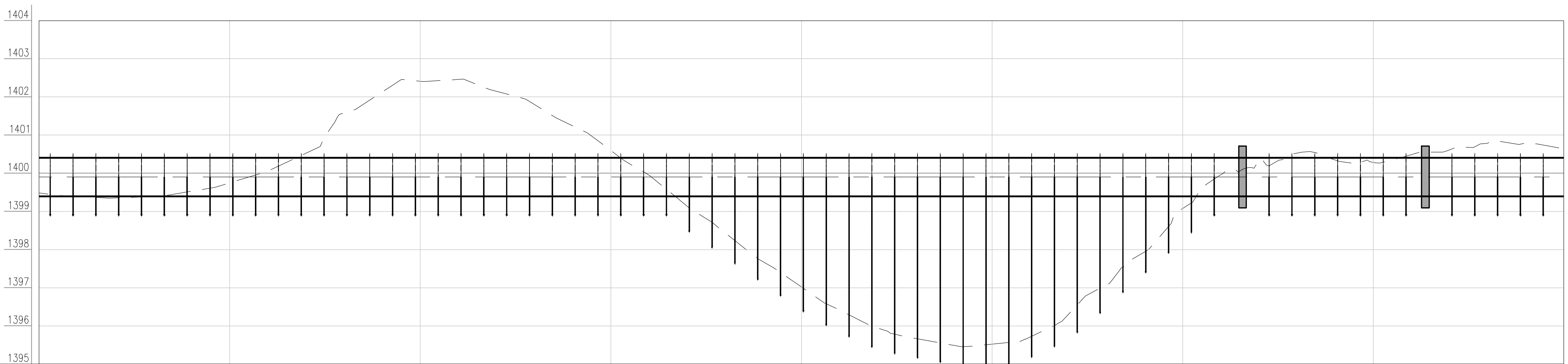
NOTE:

1. ALL DIMENSIONS, STATIONS & LEVELS ARE IN METER.

CLIENT :	CONSULTANT :	PROJECT:	DRAWING TITLE :				
ADB ASIAN DEVELOPMENT BANK	Techno-Consult International (Pvt.)Ltd.	BALOCHISTAN WATER RESOURCES DEVELOPMENT PROJECT (TA)	STEEL PIPE PLAN & PROFILE STA: AT 0+400 TO 0+800	Designed By : ABDUL HAI	Date : NOVEMBER 2017		
		SCHEME: SIRI TOI DAM ZHOB RIVER BASIN		Drawn By : ARSALAN RAFAT	Scale : AS SHOWN		
				Checked By : ZAFAR MASOOD SIDDIQUE	Drg No :		
				Approved By : DR BASHIR LAKHANI	BWRDP-ZRB-STD-OW-406		

No.	Revision	By	Date





PIPE INVERT LEVEL m	1399.400	1399.400	1399.400	1399.400	1399.400	1399.400	1399.400	1399.400	1399.400
NATURAL SURFACE LEVEL m	1399.485	1399.747	1402.413	1400.594	1397.018	1395.520	1399.078	1400.284	1400.643
DISTANCE m	0+800	0+850	0+900	0+950	1+000	1+050	1+100	1+150	1+200

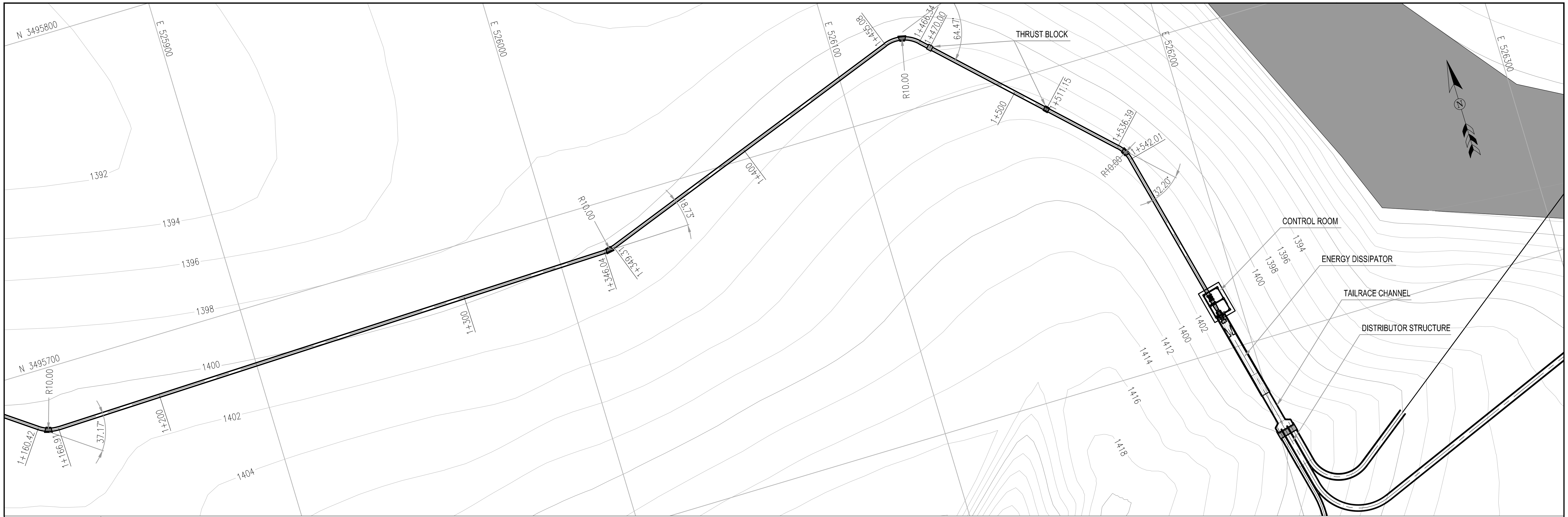
PROFILE VERTICAL SCALE:
0 2.5 5 7.5 10 m

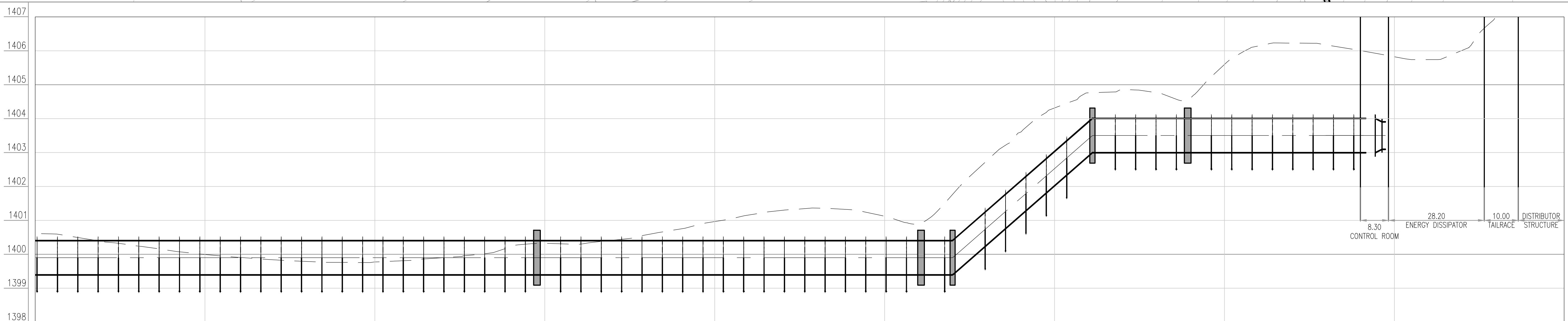
HORIZONTAL SCALE:
0 25 50 75 100 m

NOTE:
1. ALL DIMENSIONS, STATIONS & LEVELS ARE IN METER.

CLIENT : ADB ASIAN DEVELOPMENT BANK	CONSULTANT : Techno-Consult International (Pvt.)Ltd.	PROJECT: BALOCHISTAN WATER RESOURCES DEVELOPMENT PROJECT (TA) SCHEME: SIRI TOI DAM ZHOB RIVER BASIN	DRAWING TITLE : STEEL PIPE PLAN & PROFILE STA: AT 0+800 TO 1+200	Designed By : ABDUL HAI Drawn By : ARSALAN RAFAT Checked By : ZAFAR MASOOD SIDDIQUE Approved By : DR BASHIR LAKHANI	Date : NOVEMBER 2017 Scale : AS SHOWN Drg No : BWRDP-ZRB-STD-OW-407

No.	Revision	By	Date





PIPE INVERT LEVEL m	1399.400	1399.400	1399.400	1399.400	1399.400	1399.400	1403.000	1403.000	-	-
NATURAL SURFACE LEVEL m	1400.643	1399.995	1399.775	1400.324	1400.966	1401.125	1404.315	1405.595	1405.822	1408.664
DISTANCE m	1+200	1+250	1+300	1+350	1+400	1+450	1+500	1+550	1+600	1+650

PROFILE VERTICAL SCALE:

0 2.5 5 7.5 10 m

HORIZONTAL SCALE:

0 25 50 75 100 m

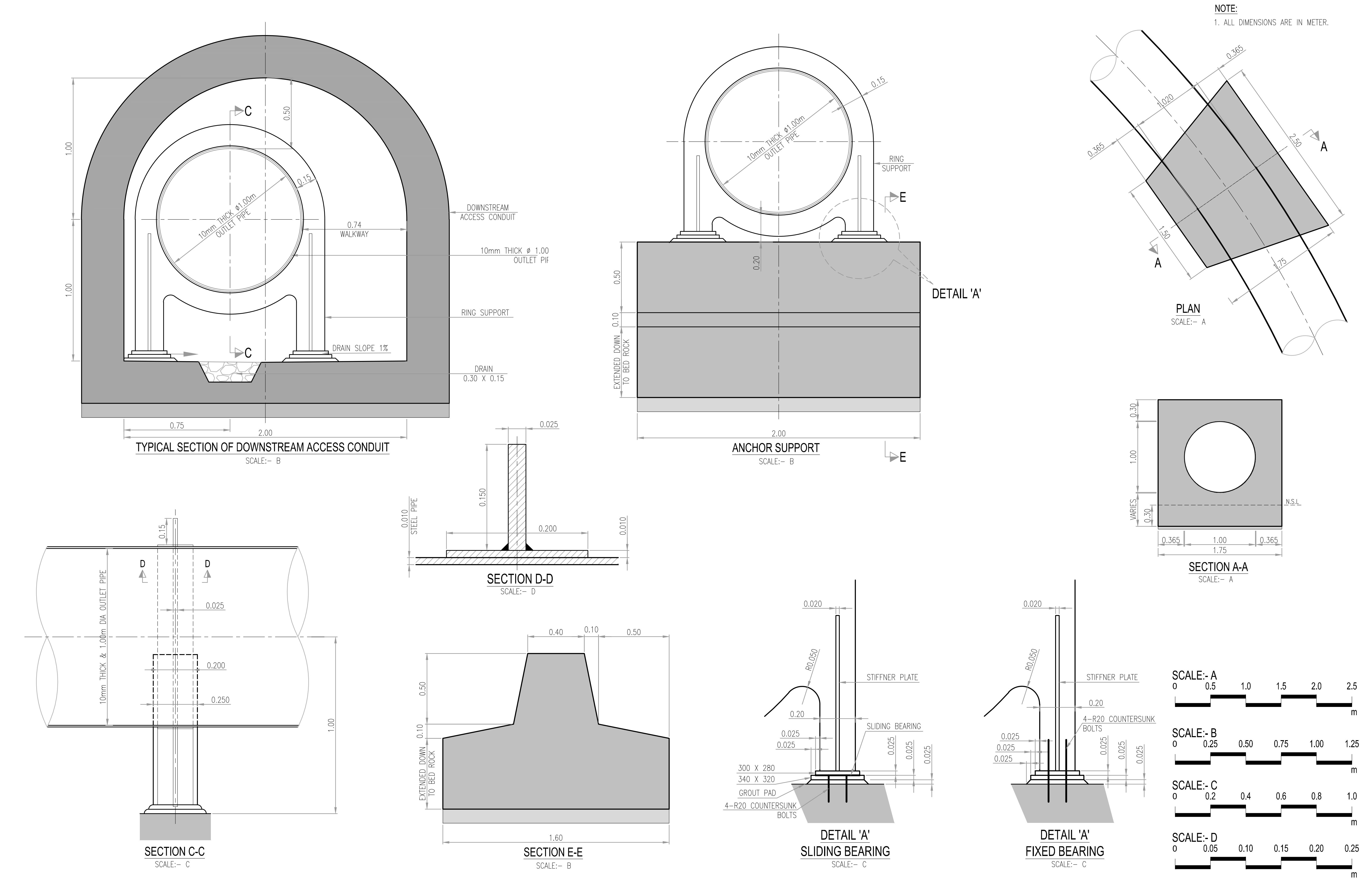
NOTE:

1. ALL DIMENSIONS, STATIONS & LEVELS ARE IN METER.

CLIENT : ADB ASIAN DEVELOPMENT BANK	CONSULTANT : Techno-Consult International (Pvt.)Ltd.	PROJECT: BALOCHISTAN WATER RESOURCES DEVELOPMENT PROJECT (TA)	DRAWING TITLE : STEEL PIPE PLAN & PROFILE STA: AT 1+200 TO 1+600	Designed By : ABDUL HAI
		SCHEME: SIRI TOI DAM ZHOB RIVER BASIN		Drawn By : ARSALAN RAFAT
				Checked By : ZAFAR MASOOD SIDDIQUE
				Approved By : DR BASHIR LAKHANI

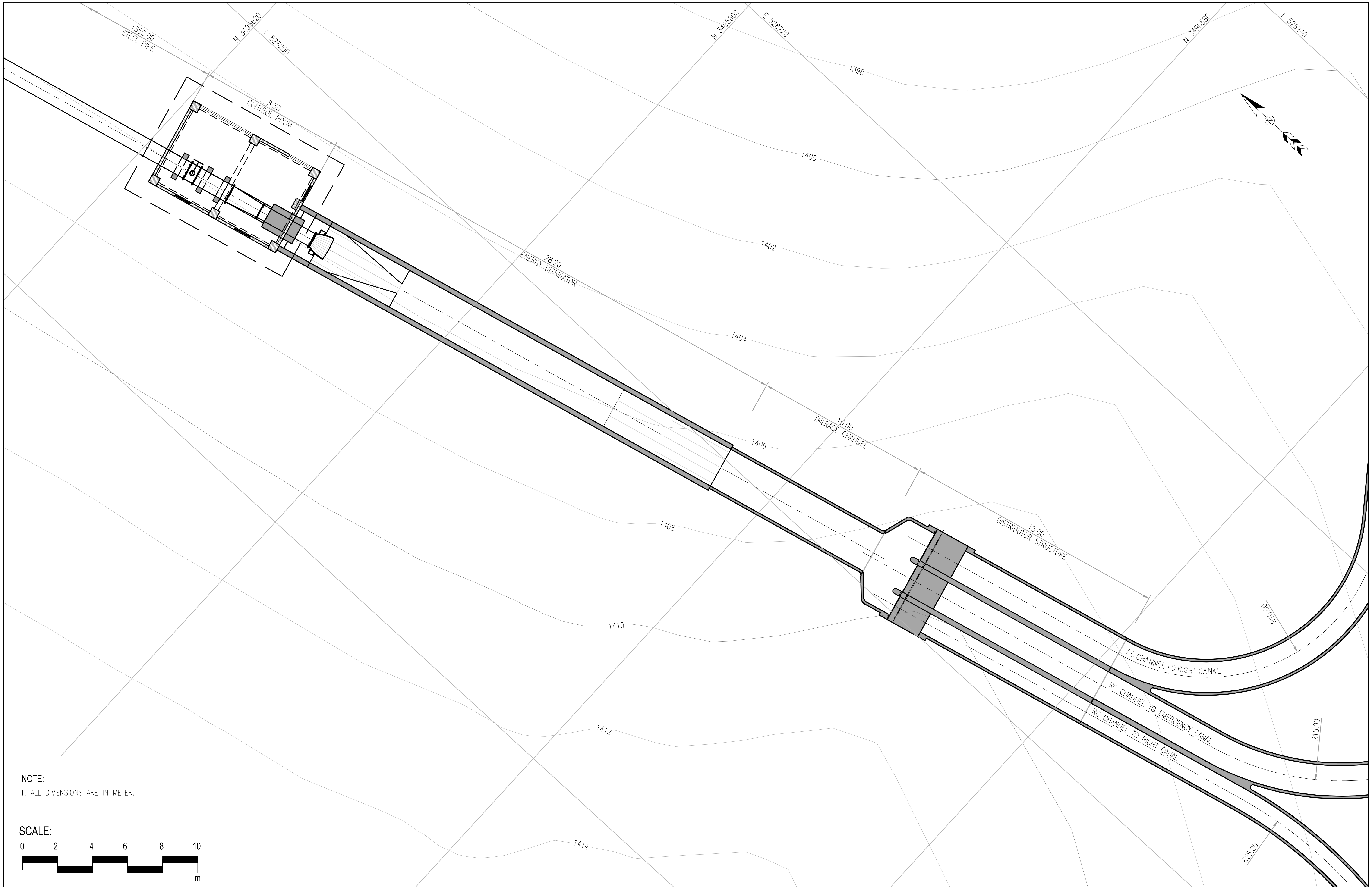
Date :	NOVEMBER 2017
Scale :	AS SHOWN
Drg No :	BWRDP-ZRB-STD-OW-408

No.	Revision	By	Date



CLIENT : ADB ASIAN DEVELOPMENT BANK	CONSULTANT : Techno-Consult International (Pvt.)Ltd.	PROJECT: BALOCHISTAN WATER RESOURCES DEVELOPMENT PROJECT (TA)	DRAWING TITLE : STEEL PIPE ANCHOR BLOCK & PIPE SUPPORT DETAILS	Designed By : ABDUL HAI	Date : NOVEMBER 2017
		SCHEME: SIRI TOI DAM ZHOB RIVER BASIN		Drawn By : ARSALAN RAFAT	Scale : AS SHOWN
				Checked By : ZAFAR MASOOD SIDDIQUE	Drg No :
				Approved By : DR BASHIR LAKHANI	BWRDP-ZRB-STD-OW-409

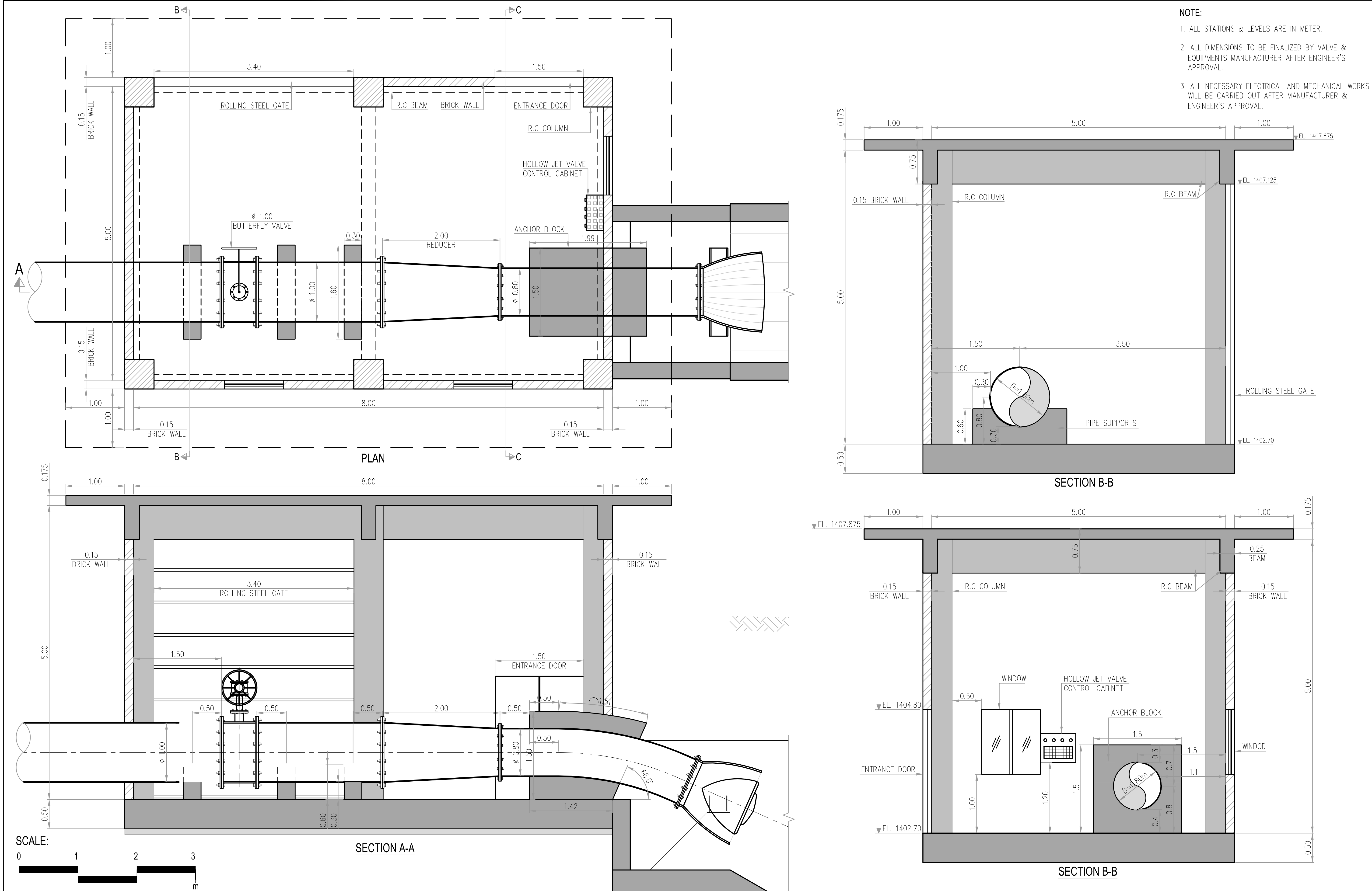
No.	Revision	By	Date



NOTE:

1. ALL DIMENSIONS ARE IN METER.

CLIENT :	CONSULTANT :	PROJECT:	DRAWING TITLE :				
ADB ASIAN DEVELOPMENT BANK	Techno-Consult International (Pvt.)Ltd.	BALOCHISTAN WATER RESOURCES DEVELOPMENT PROJECT (TA)	ARRANGEMENT PLAN OF STEEL PIPE - CONTROL ROOM - ENERGY DISSIPATOR - TAILRACE CHANNEL - DISTRIBUTOR STRUCTURE - RC CHANNELS	Designed By : ABDUL HAI	Date : NOVEMBER 2017	No.	Revision
		SCHEME:		Drawn By : ARSALAN RAFAT	Scale : AS SHOWN	By	Date
		SIRI TOI DAM ZHOB RIVER BASIN		Checked By : ZAFAR MASOOD SIDDIQUE	Drg No :		
				Approved By : DR BASHIR LAKHANI	BWRDP-ZRB-STD-OW-451		



NOTE:

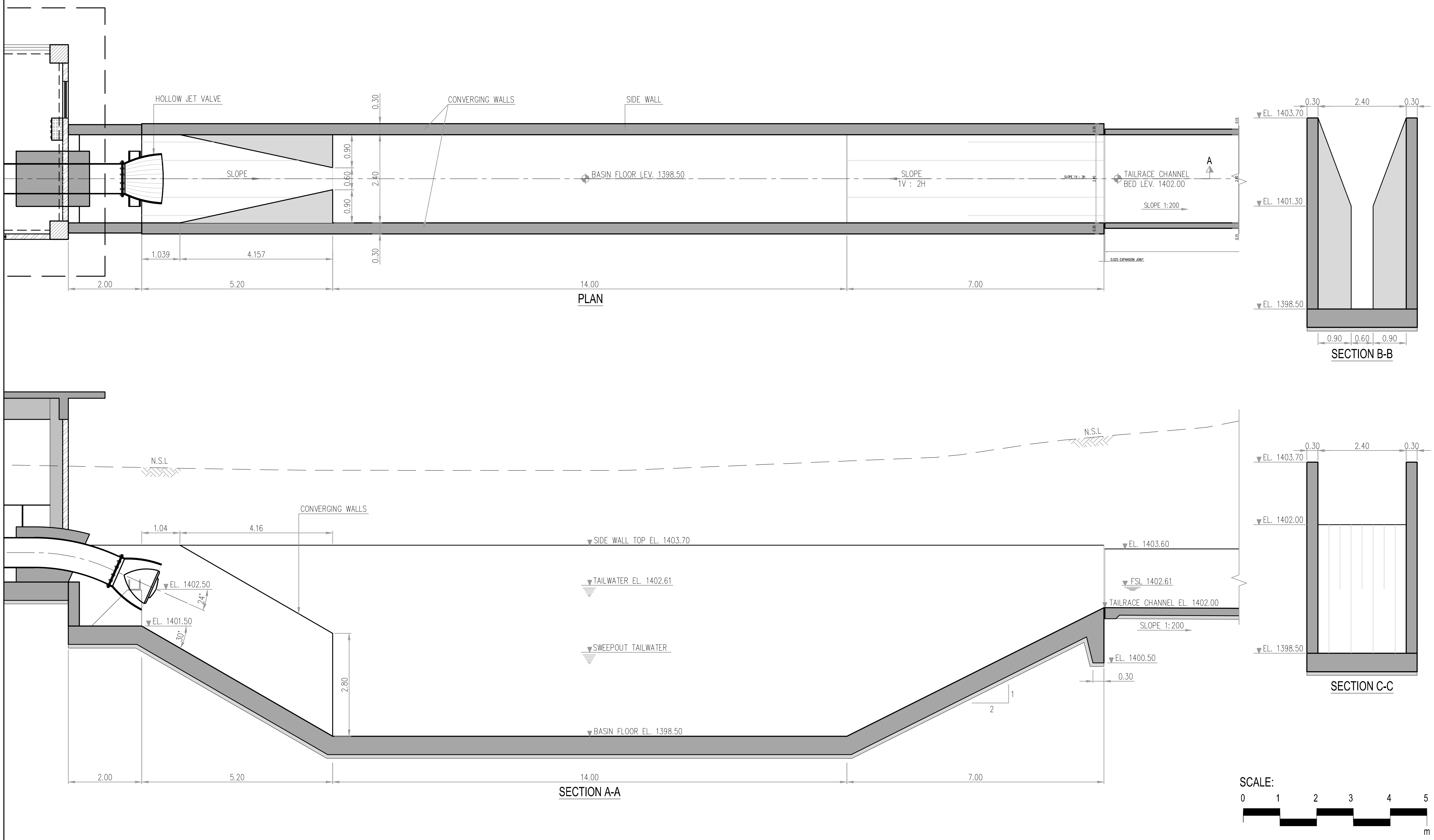
1. ALL STATIONS & LEVELS ARE IN METER.
2. ALL DIMENSIONS TO BE FINALIZED BY VALVE & EQUIPMENTS MANUFACTURER AFTER ENGINEER'S APPROVAL.
3. ALL NECESSARY ELECTRICAL AND MECHANICAL WORKS WILL BE CARRIED OUT AFTER MANUFACTURER & ENGINEER'S APPROVAL.

CLIENT : ADB ASIAN DEVELOPMENT BANK	CONSULTANT : Techno-Consult International (Pvt.) Ltd.	PROJECT: BALOCHISTAN WATER RESOURCES DEVELOPMENT PROJECT (TA)	DRAWING TITLE : OUTLET WORKS VALVES CONTROL ROOM PLAN & SECTIONS	
		SCHEME: SIRI TOI DAM ZHOB RIVER BASIN		

Designed By :	ABDUL HAI	Date :	NOVEMBER 2017
Drawn By :	ARSALAN RAFAT	Scale :	AS SHOWN
Checked By :	ZAFAR MASOOD SIDDIQUE	Drg No :	
Approved By :	DR BASHIR LAKHANI		BWRDP-ZRB-STD-OW-452

No.	Revision	By	Date

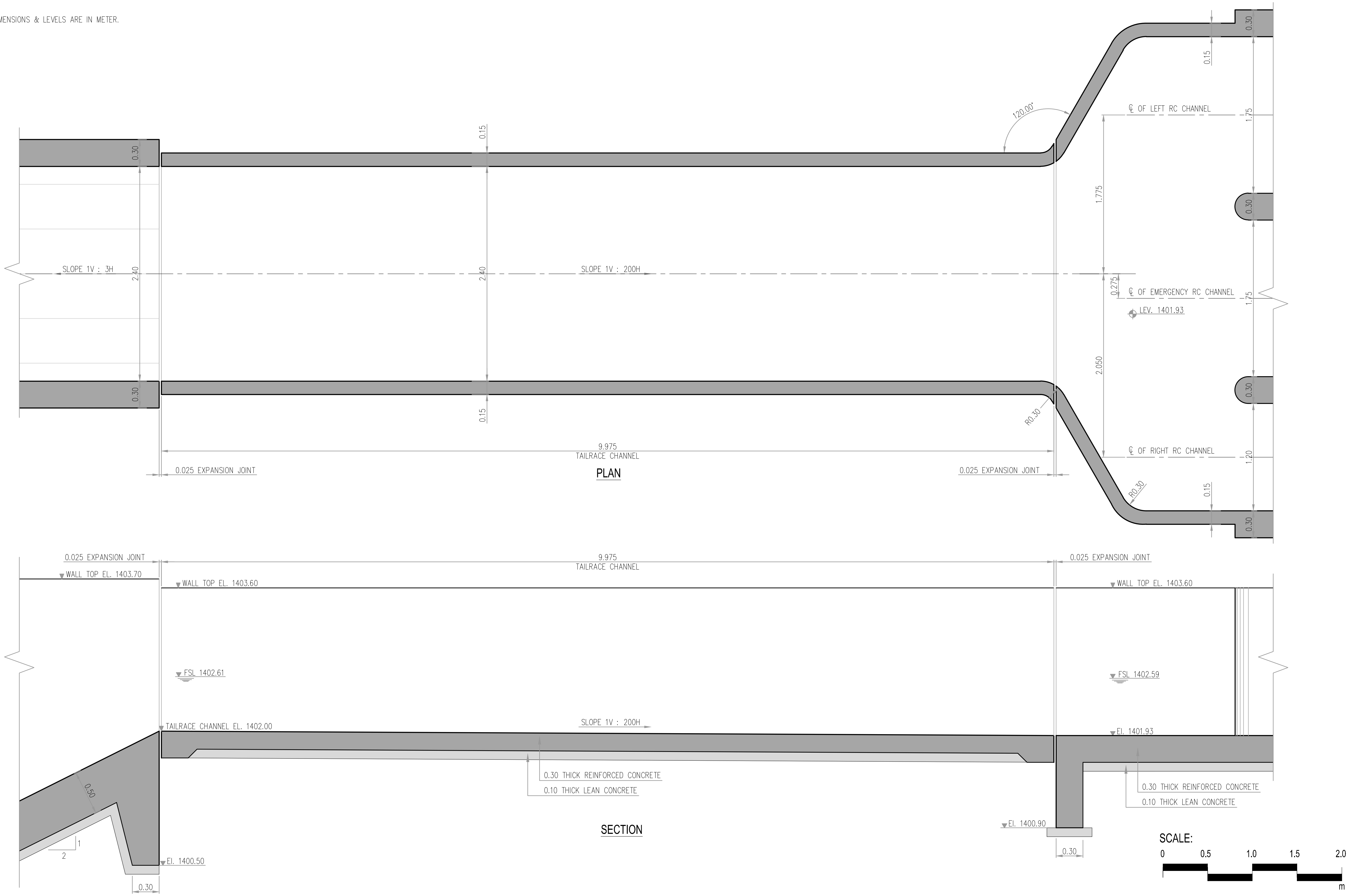
NOTE:
1. ALL DIMENSIONS & LEVELS ARE IN METER.



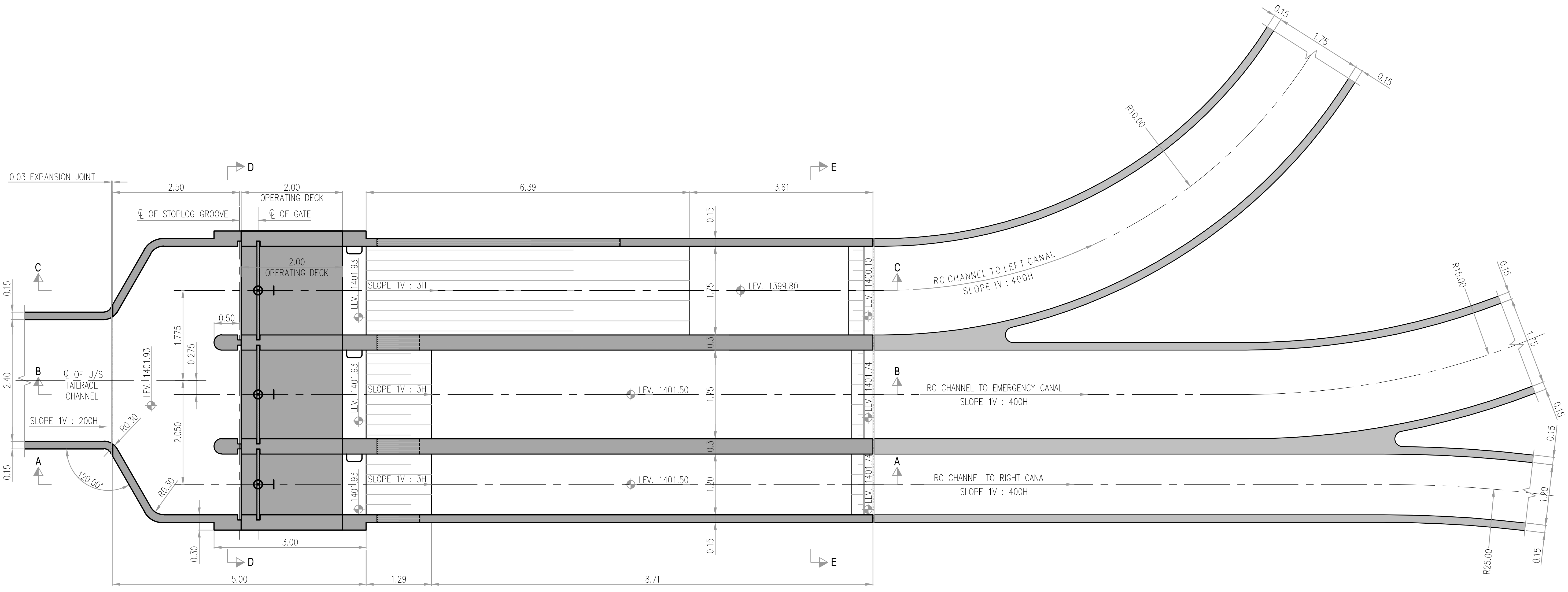
CLIENT :	CONSULTANT :	PROJECT:	DRAWING TITLE :				
ADB ASIAN DEVELOPMENT BANK	Techno-Consult International (Pvt.)Ltd.	BALOCHISTAN WATER RESOURCES DEVELOPMENT PROJECT (TA)	OUTLET WORKS ENERGY DISSIPATOR PLAN & SECTIONS	Designed By : ABDUL HAI	Date : NOVEMBER 2017	No.	Revision
		SCHEME: SIRI TOI DAM ZHOB RIVER BASIN		Drawn By : ARSALAN RAFAT	Scale : AS SHOWN	By	Date
				Checked By : ZAFAR MASOOD SIDDIQUE	Drg No :		
				Approved By : DR BASHIR LAKHANI	BWRDP-ZRB-STD-OW-453		

NOTE:

1. ALL DIMENSIONS & LEVELS ARE IN METER.



CLIENT :	CONSULTANT :	PROJECT:	DRAWING TITLE :				
ADB ASIAN DEVELOPMENT BANK	Techno-Consult International (Pvt.)Ltd.	BALOCHISTAN WATER RESOURCES DEVELOPMENT PROJECT (TA)	OUTLET WORKS TAILRACE CHANNEL PLAN & SECTION	Designed By : ABDUL HAI	Date : NOVEMBER 2017	No.	Revision	By	Date
		SCHEME: SIRI TOI DAM ZHOB RIVER BASIN		Drawn By : ARSALAN RAFAT	Scale : AS SHOWN				
				Checked By : ZAFAR MASOOD SIDDIQUE	Drg No :				
				Approved By : DR BASHIR LAKHANI	BWRDP-ZRB-STD-OW-454				



NOTE:

1. ALL DIMENSIONS & LEVELS ARE IN METER.

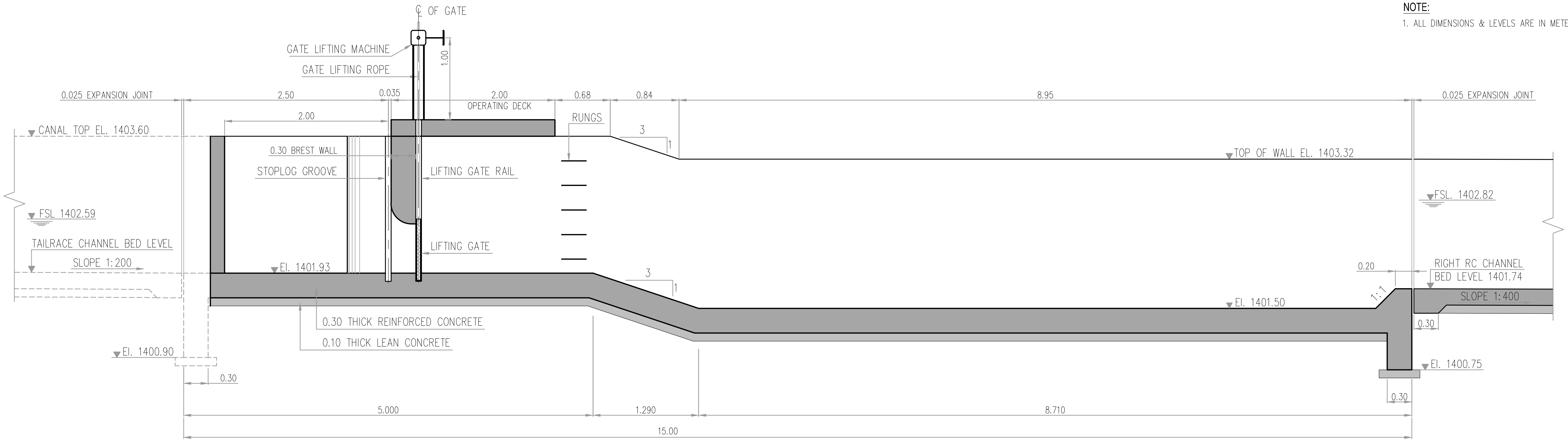
SCALE:

0 1 2 3 4 5 m

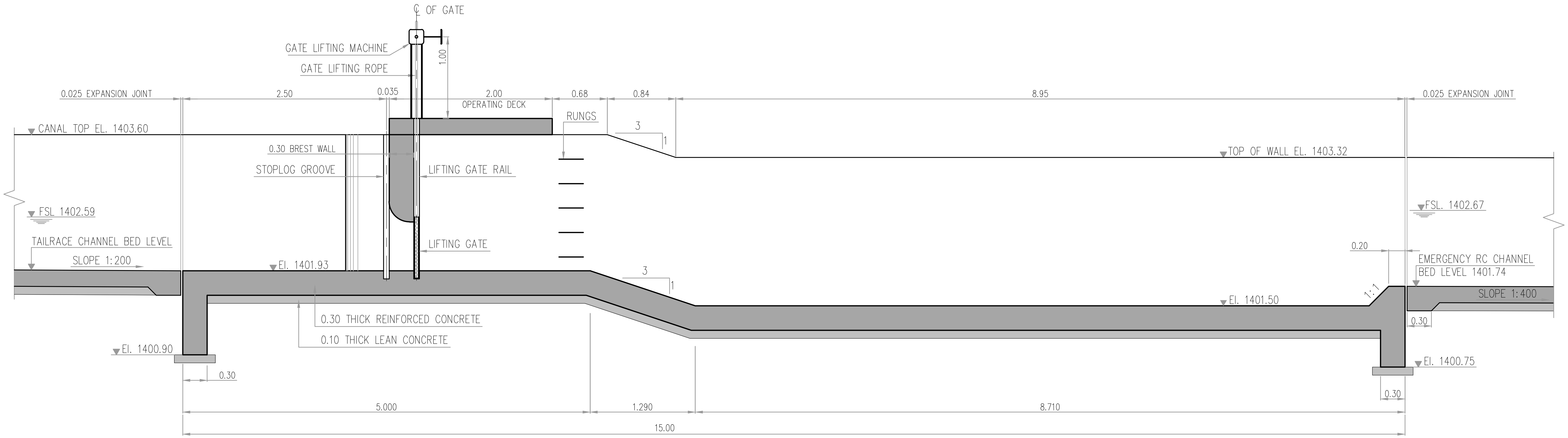
CLIENT : ADB ASIAN DEVELOPMENT BANK	CONSULTANT : Techno-Consult International (Pvt.)Ltd.	PROJECT: BALOCHISTAN WATER RESOURCES DEVELOPMENT PROJECT (TA)	DRAWING TITLE : DISTRIBUTOR STRUCTURE DETAIL PLAN	Designed By : ABDUL HAI — Date : NOVEMBER 2017
		SCHEME: SIRI TOI DAM ZHOB RIVER BASIN		Drawn By : ARSALAN RAFAT — Scale : AS SHOWN
				Checked By : ZAFAR MASOOD SIDDIQUE — Drg No :
				Approved By : DR BASHIR LAKHANI — BWRDP-ZRB-STD-OW-455

No.	Revision	By	Date

NOTE:
1. ALL DIMENSIONS & LEVELS ARE IN METER.



SECTION A-A
RIGHT TAILRACE CANAL

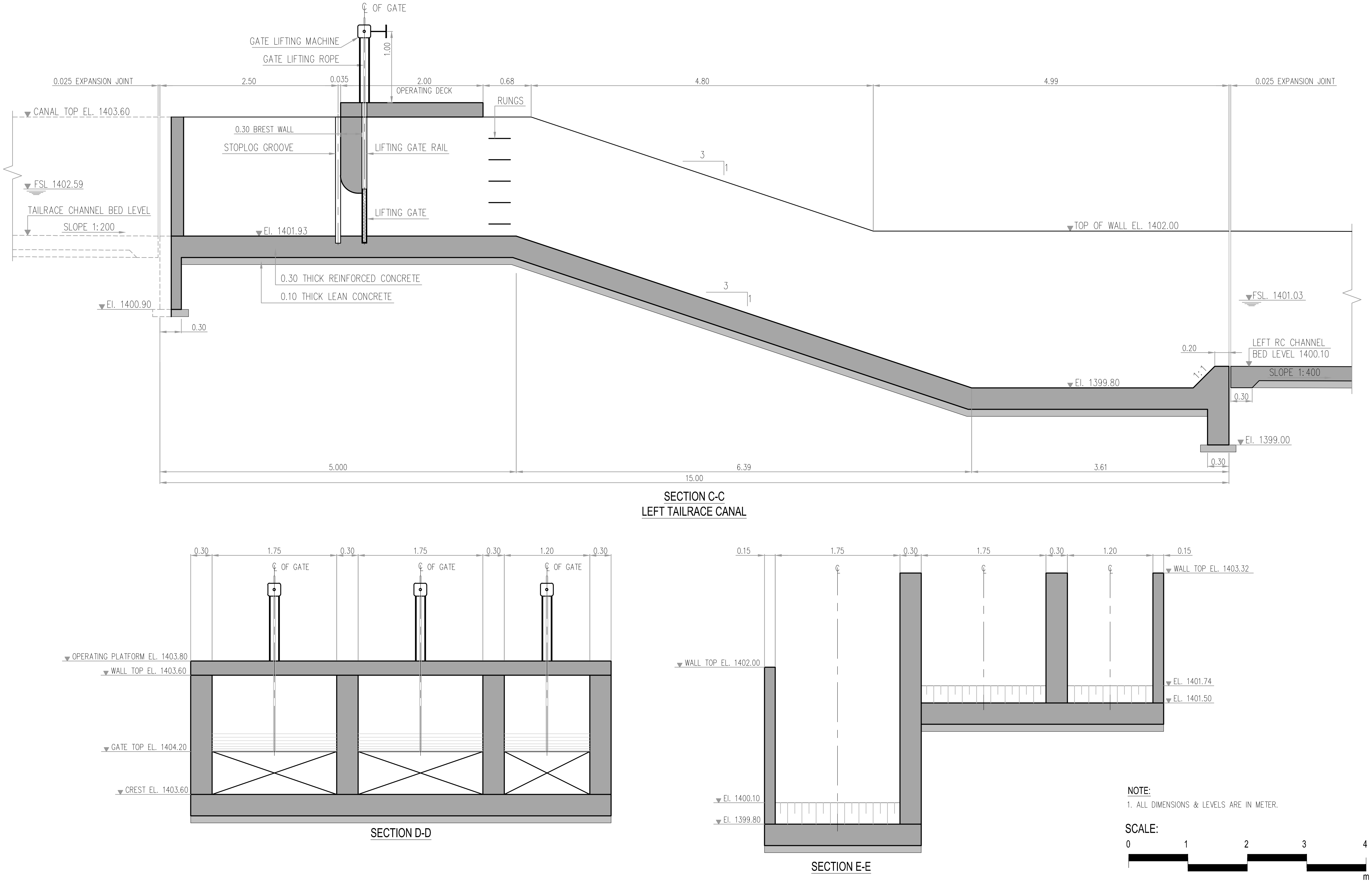


SECTION B-B
EMERGENCY TAILRACE CANAL

SCALE:
0 1 2 3 4
m

CLIENT: ADB ASIAN DEVELOPMENT BANK	CONSULTANT: Techno-Consult International (Pvt.)Ltd.	PROJECT: BALOCHISTAN WATER RESOURCES DEVELOPMENT PROJECT (TA)	DRAWING TITLE: DISTRIBUTOR STRUCTURE SECTION A-A & B-B	Designed By: ABDUL HAI	Date: NOVEMBER 2017
				Drawn By: ARSALAN RAFAT	Scale: AS SHOWN
		SCHEME: SIRI TOI DAM ZHOB RIVER BASIN		Checked By: ZAFAR MASOOD SIDDIQUE	Drg No:
				Approved By: DR BASHIR LAKHANI	BWRDP-ZRB-STD-OW-456

No.	Revision	By	Date



NOTE:

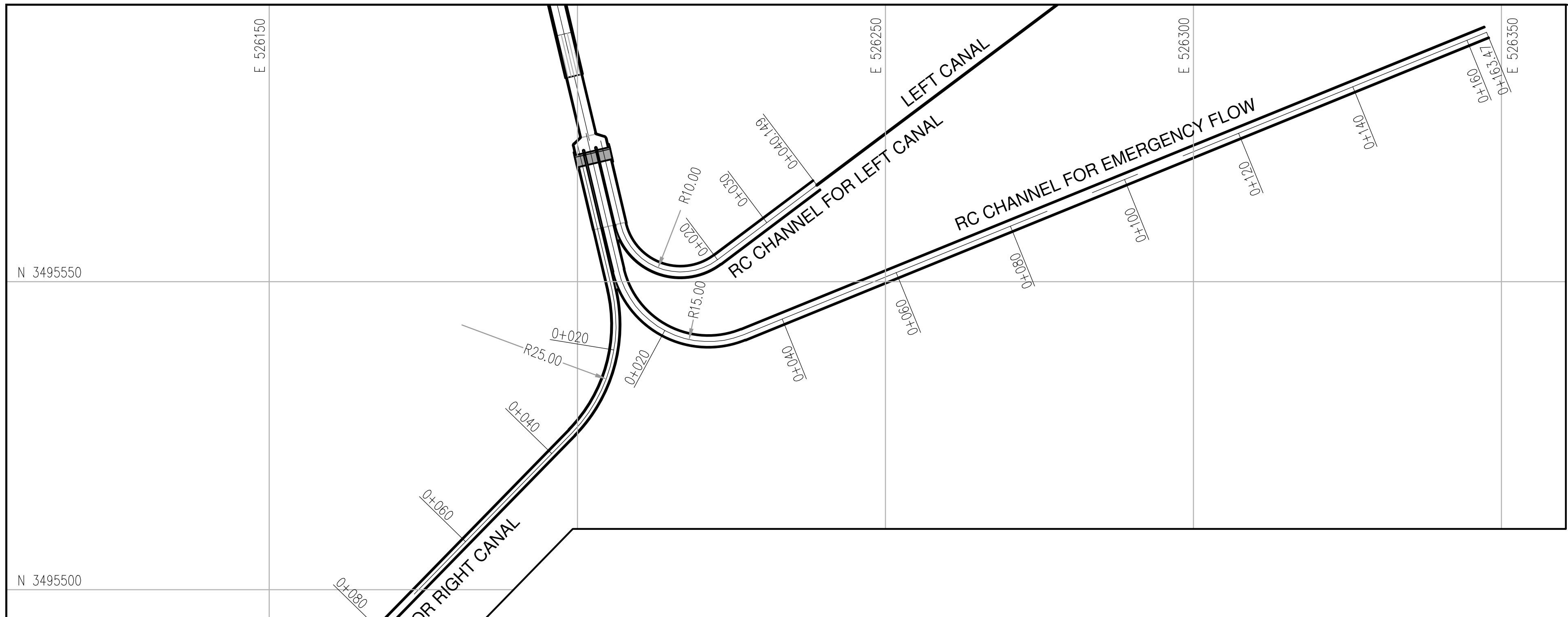
1. ALL DIMENSIONS & LEVELS ARE IN METER.

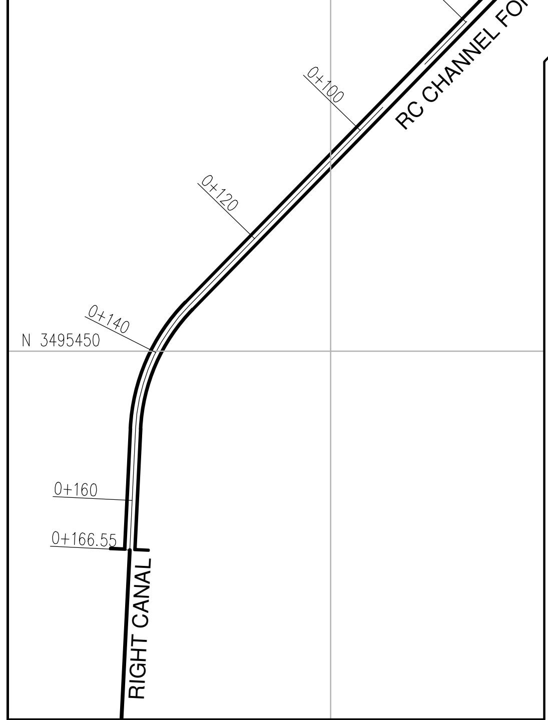
SCALE:

0 1 2 3 4 m

CLIENT : ADB ASIAN DEVELOPMENT BANK	CONSULTANT : Techno-Consult International (Pvt.)Ltd.	PROJECT: BALOCHISTAN WATER RESOURCES DEVELOPMENT PROJECT (TA)	DRAWING TITLE : DISTRIBUTOR STRUCTURE SECTION C-C, D-D & E-E	Designed By : ABDUL HAI	Date : NOVEMBER 2017
		SCHEME: SIRI TOI DAM ZHOB RIVER BASIN		Drawn By : ARSALAN RAFAT	Scale : AS SHOWN
				Checked By : ZAFAR MASOOD SIDDIQUE	Drg No :
				Approved By : DR BASHIR LAKHANI	BWRDP-ZRB-STD-OW-457

No.	Revision	By	Date



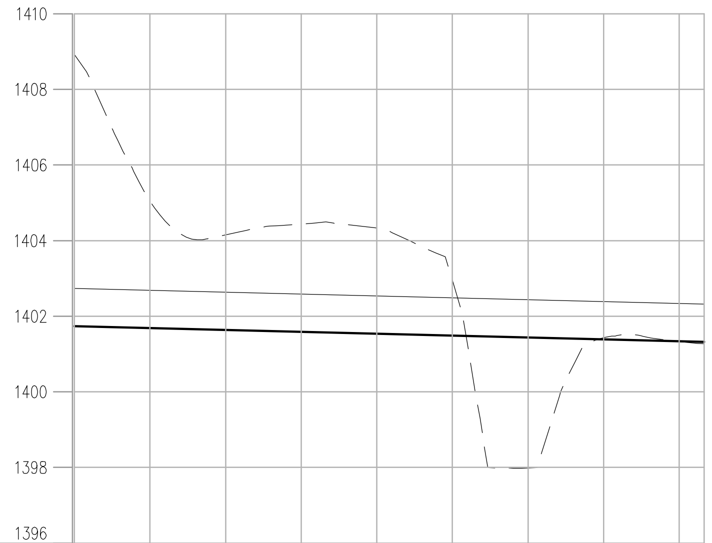


NOTE:
1. ALL DIMENSIONS & LEVELS ARE IN METER.

PLAN SCALE: 0 10 20 30 40 50 m

HORIZONTAL SCALE: 0 20 40 60 80 100 m

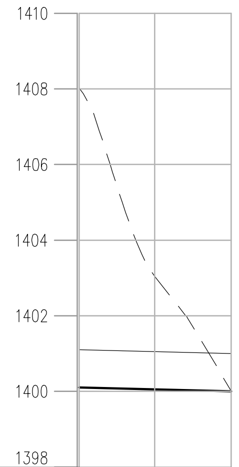
VERTICAL SCALE: 0 2 4 6 8 10 m



DATUM	1396
BED SLOPE	0.0025
VELOCITY	1.18
DESIGN FLOW (CUMECS)	1.53
CANAL TYPE	RECTANGULAR
BED WIDTH, B (m)	1.20
CANAL DEPTH, D (m)	1.00

DISTANCE (m)	BTL (m)	DBL (m)	NSL (m)
0+000	1403.320	1401.740	1408.923
0+020	1403.270	1401.690	1405.049
0+040	1403.220	1401.640	1404.154
0+060	1403.170	1401.590	1404.439
0+080	1403.120	1401.540	1404.333
0+100	1403.070	1401.490	1402.941
0+120	1403.020	1401.440	1397.987
0+140	1402.970	1401.390	1401.433
0+160	1402.920	1401.340	1401.328
0+166	1402.904	1401.324	1401.275

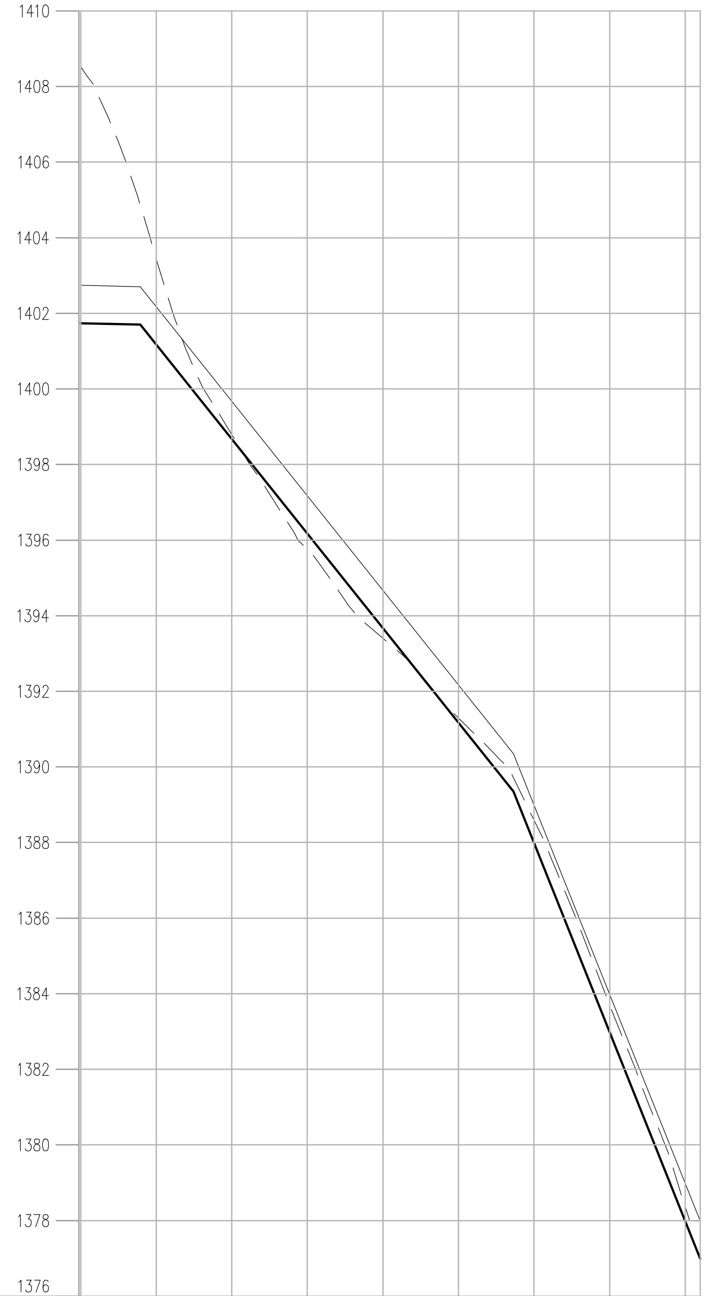
PROFILE OF RC CHANNEL
FOR RIGHT CANAL



DATUM	1398
BED SLOPE	0.0025
VELOCITY	1.37
DESIGN FLOW (CUMECS)	2.23
CANAL TYPE	RECTANGULAR
BED WIDTH, B (m)	1.75
CANAL DEPTH, D (m)	1.00

DISTANCE (m)	BTL (m)	DBL (m)	NSL (m)
0+000	1402.000	1400.102	1408.027
0+020	1401.929	1400.052	1403.035
0+040	1401.879	1400.002	1400.011

PROFILE OF RC CHANNEL
FOR LEFT CANAL



DATUM	1376
BED SLOPE	0.0025 / 0.125 / 0.250
VELOCITY	1.37
DESIGN FLOW (CUMECS)	2.23
CANAL TYPE	RECTANGULAR
BED WIDTH, B (m)	1.75
CANAL DEPTH, D (m)	1.00

DISTANCE (m)	BTL (m)	DBL (m)	NSL (m)
0+000	1403.320	1401.740	1408.521
0+020	1402.755	1401.175	1403.449
0+040	1400.255	1398.675	1398.797
0+060	1397.755	1396.175	1395.754
0+080	1395.255	1393.675	1393.400
0+100	1392.755	1391.175	1391.298
0+120	1389.580	1388.000	1388.593
0+140	1384.580	1383.000	1383.704
0+160	1379.580	1378.000	1378.372
0+166	1378.573	1376.993	1377.506

PROFILE OF RC CHANNEL
FOR EMERGENCY FLOW

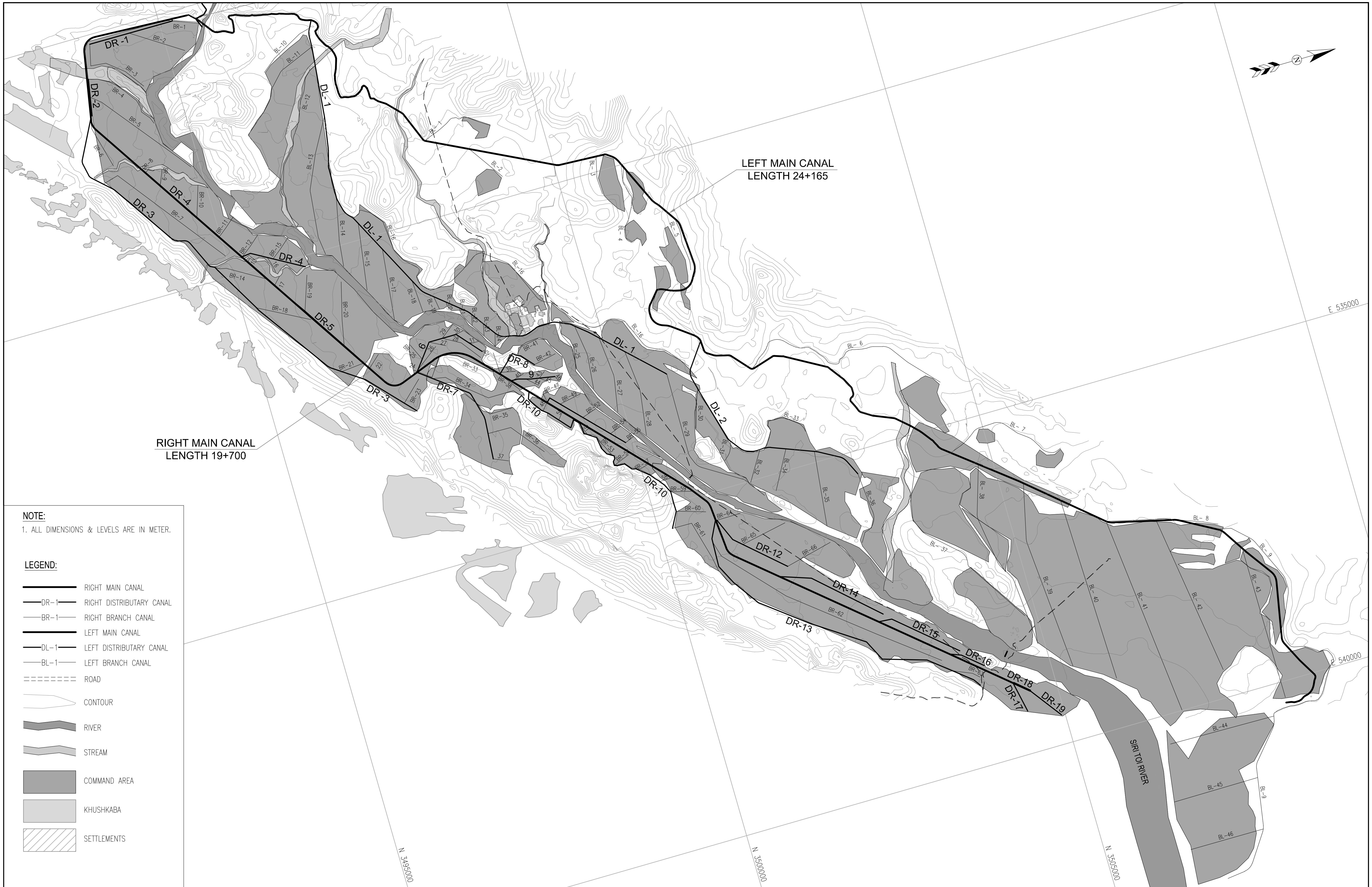
CLIENT: ADB ASIAN DEVELOPMENT BANK	CONSULTANT: Techno-Consult International (Pvt.)Ltd.	PROJECT: BALOCHISTAN WATER RESOURCES DEVELOPMENT PROJECT (TA)	DRAWING TITLE: RC CHANNELS PLAN & PROFILE	Designed By: ABDUL HAI; Date: NOVEMBER 2017
		SCHEME: SIRI TOI DAM ZHOB RIVER BASIN		Drawn By: ARSALAN RAFAT; Scale: AS SHOWN
				Checked By: ZAFAR MASOOD SIDDIQUE; Drg No: BWRDP-ZRB-STD-OW-458
				Approved By: DR BASHIR LAKHANI

No.	Revision	By	Date

SIRI TOI DAM

IRRIGATION CANAL

PLAN & PROFILE



NOTE:

1. ALL DIMENSIONS & LEVELS ARE IN METER.

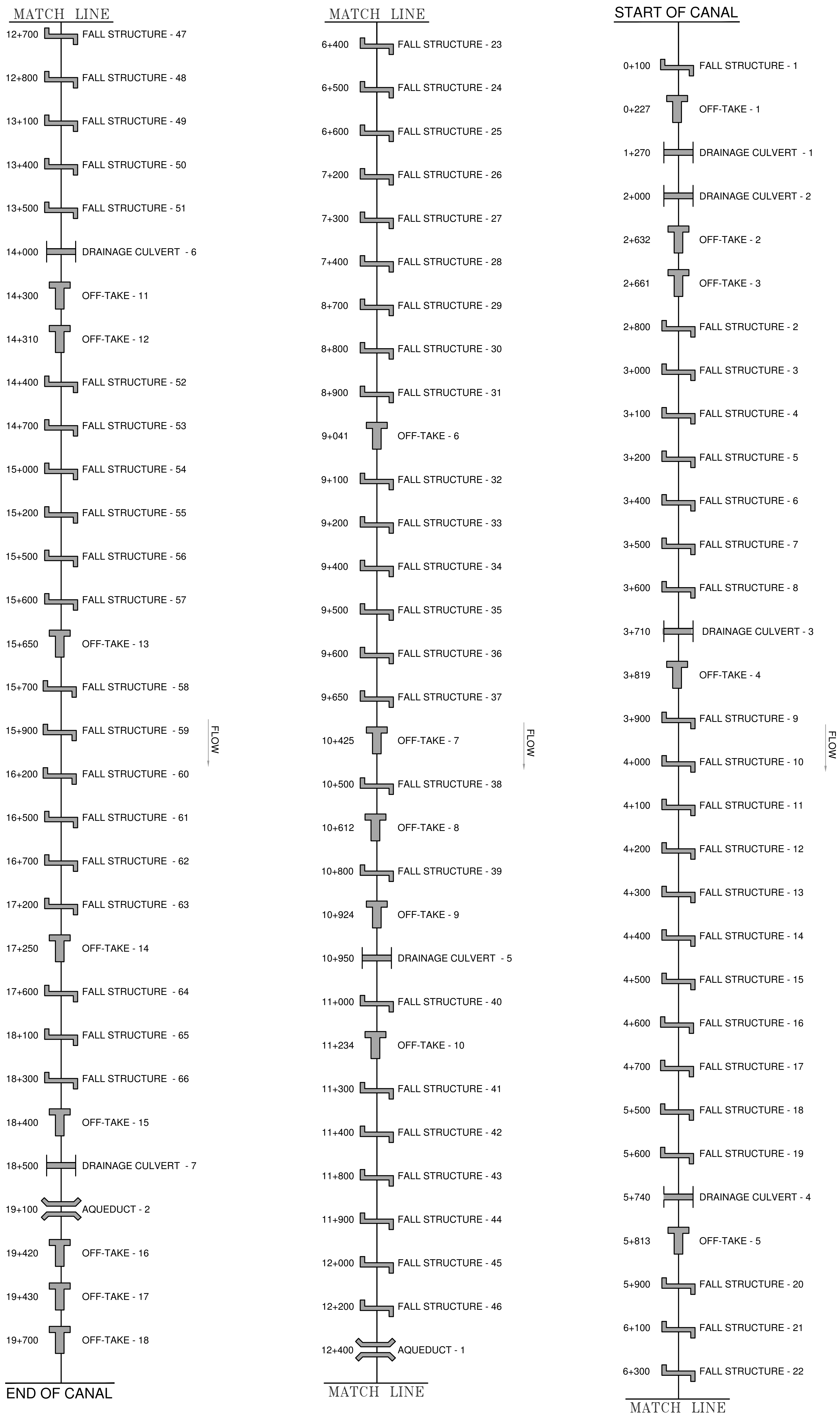
LEGEND:

- RIGHT MAIN CANAL
- DR-1 RIGHT DISTRIBUTARY CANAL
- BR-1 RIGHT BRANCH CANAL
- LEFT MAIN CANAL
- DL-1 LEFT DISTRIBUTARY CANAL
- BL-1 LEFT BRANCH CANAL
- ROAD
- CONTOUR
- RIVER
- STREAM
- COMMAND AREA
- KHUSHKABA
- SETTLEMENTS

CLIENT: ASIAN DEVELOPMENT BANK	CONSULTANT: Techno-Consult International (Pvt.) Ltd.	PROJECT: BALOCHISTAN WATER RESOURCES DEVELOPMENT PROJECT (TA)	DRAWING TITLE: IRRIGATION SYSTEM LAYOUT PLAN	
		SCHEME: SIRI TOI DAM ZHOB RIVER BASIN		

Designed By :	SAAD / MEHROZ	Date :	NOVEMBER 2017
Drawn By :	ARSALAN RAFAT	Scale :	N.T.S
Checked By :	ZAFAR MASOOD SIDDIQUE	Drg No :	
Approved By :	DR BASHIR LAKHANI		BWRDP-ZRB-STD-PP-501

No.	Revision	By	Date



CLIENT:
ASIAN DEVELOPMENT BANK

CONSULTANT:
Techno-Consult International (Pvt.) Ltd.

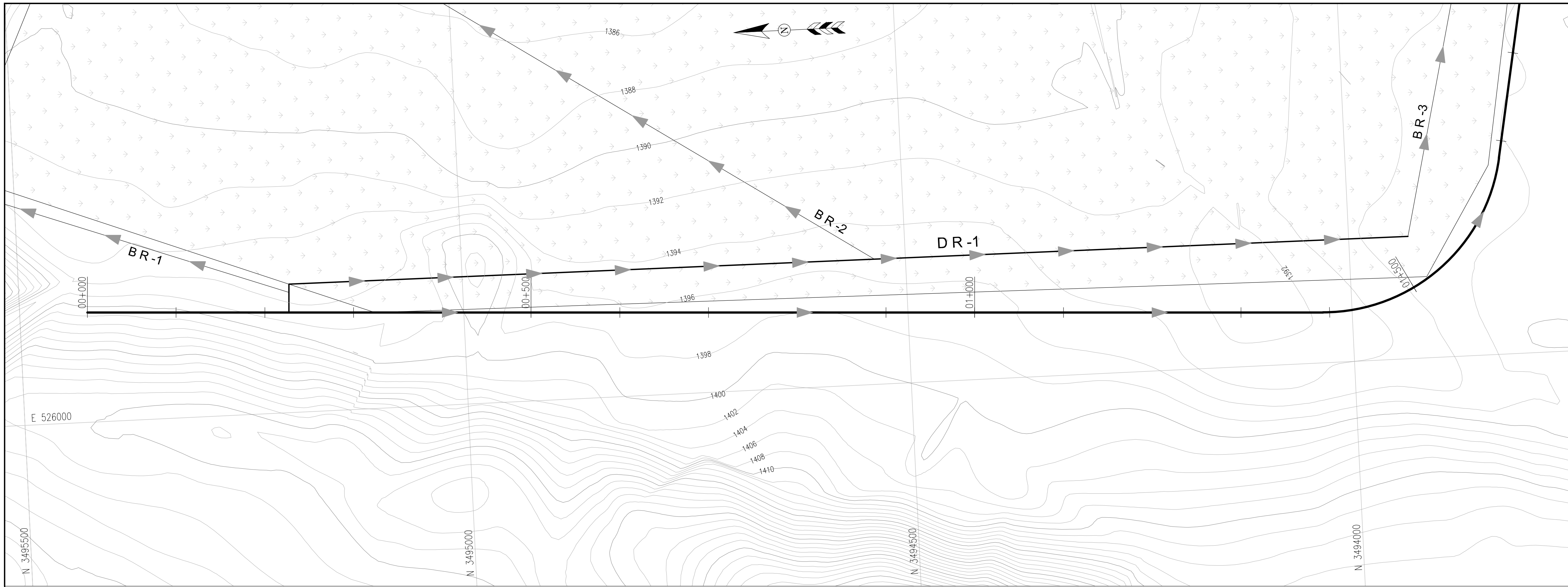
PROJECT:
BALOCHISTAN WATER RESOURCES DEVELOPMENT PROJECT (TA)

SCHEME:
SIRI TOI DAM
ZHOB RIVER BASIN

DRAWING TITLE:
RIGHT CANAL
LINE DIAGRAM

Designed By:	MEHROZ AFTAB	Date:	NOVEMBER 2017
Drawn By:	FARHAN AHMED	Scale:	-
Checked By:	ZAFAR MASOOD SIDDIQUE	Drg No:	BWRDP-ZRB-STD-PP-602
Approved By:	DR BASHIR LAKHANI		

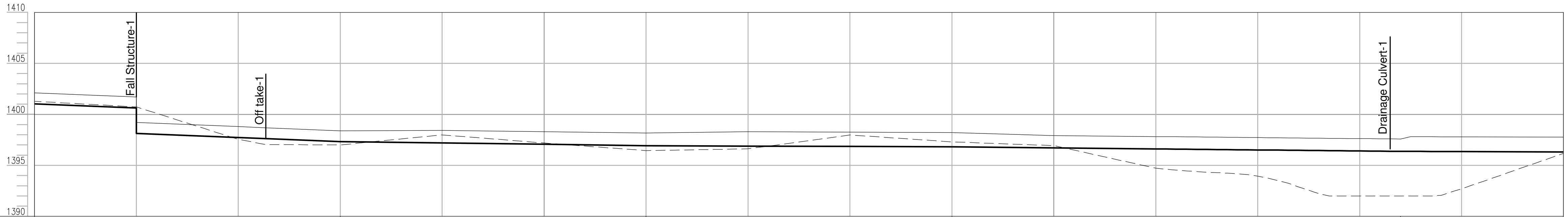
No.	Revision



NOTE:
1. ALL DIMENSIONS & LEVELS ARE IN METER.

LEGEND:

- MAIN CANAL
- DR-1 DISTRIBUTARY CANAL
- BR-1 BRANCH CANAL
- ROAD
- 1400 CONTOUR
- RIVER
- STREAM
- COMMAND AREA
- SETTLEMENTS
- FALL STRUCTURE



DATUM	
BED SLOPE	0.0040 (00+000 – 00+300); 0.0013 (00+300 – 00+600); 0.0004 (00+600 – 00+900); 0.0010 (00+900 – 01+340); 0.0003 (01+340 – 01+500)
VELOCITY	1.97; 1.94; 1.29; 0.82; 1.15; 0.77
DESIGN FLOW (CUMECS)	1.50; 1.40
CANAL TYPE	TRAPEZOIDAL
BED WIDTH, B (m)	0.75; 1.00
CANAL DEPTH, D (m)	1.07; 1.05; 1.23; 1.40; 1.21; 1.44

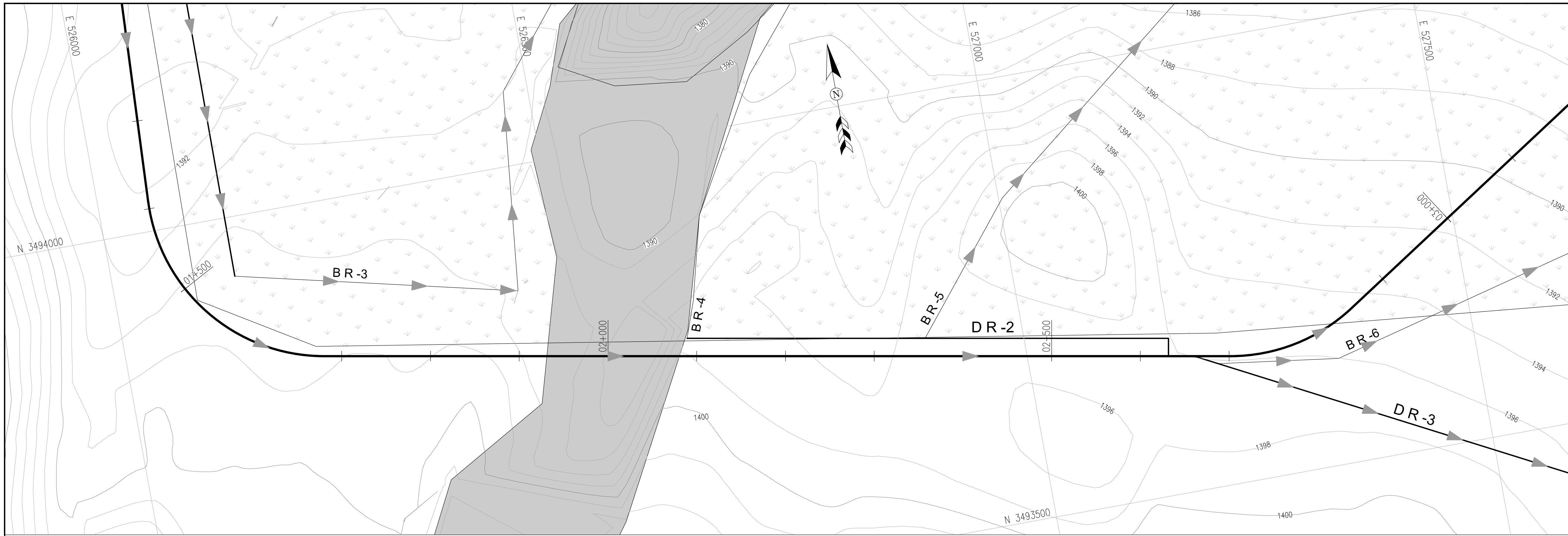
DISTANCE (m)	BTL (m)	DBL (m)	NSL (m)
000	1402.105	1401.031	1401.281
0+100	1401.705 / 1399.205	1400.631 / 1398.131	1400.730
00+200	1398.805	1397.731	1397.549
00+227	1398.677	1397.623	1397.037
00+300	1398.385	1397.331	1396.998
00+400	1398.431	1397.198	1397.990
00+500	1398.297	1397.064	1397.191
00+600	1398.164	1396.931	1396.443
00+700	1398.290	1396.891	1396.619
00+800	1398.250	1396.851	1397.976
00+900	1398.210	1396.811	1397.302
01+000	1397.922	1396.711	1396.934
01+100	1397.822	1396.611	1394.721
01+200	1397.722	1396.511	1393.949
01+300	1397.622	1396.411	1392.000
01+400	1397.793	1396.351	1392.697
01+500	1397.759	1396.318	1396.180

HORIZONTAL
0 50 100 200
m

VERTICAL (PROFILE)
0 5 10 20
m

CLIENT :	CONSTRUCTION SUPERVISION:	PROJECT:	DRAWING TITLE :			
ADB ASIAN DEVELOPMENT BANK	Techno-Consult International (Pvt.)Ltd.	BALOCHISTAN WATER RESOURCES DEVELOPMENT PROJECT (TA)	RIGHT CHANNEL PLAN & PROFILE AT 0+000 TO 1+500	Designed By : SAAD-UR-REHMAN	Date : NOVEMBER 2017	
		SCHEME: SIRI TOI DAM ZHOB RIVER BASIN		Drawn By : ARSALAN RAFAT	Scale : AS SHOWN	
				Checked By : ZAFAR MASOOD SIDDIQUE	Drg No :	
				Approved By : DR BASHIR LAKHANI	BWRDP-ZRB-STD-PP-503	

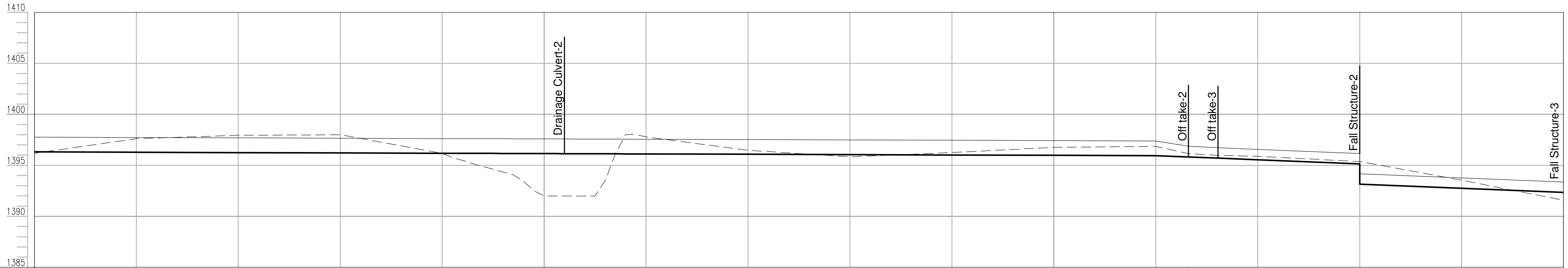
No.	Revision	By	Date



NOTE:
1. ALL DIMENSIONS & LEVELS ARE IN METER.

LEGEND:

- MAIN CANAL
- DR-1 DISTRIBUTARY CANAL
- BR-1 BRANCH CANAL
- ROAD
- 1400 CONTOUR
- RIVER
- STREAM
- COMMAND AREA
- SETTLEMENTS
- FALL STRUCTURE



DATUM

BED SLOPE	0.0003	0.0040
VELOCITY	0.77	1.87
DESIGN FLOW (CUMECS)	1.40	1.22
CANAL TYPE	TRAPEZOIDAL	TRAPEZOIDAL
BED WIDTH, B (m)	1.00	0.75
CANAL DEPTH, D (m)	1.44	1.02

DISTANCE (m)	BTL (m)	DBL (m)	NSL (m)
01+500	1397.759	1396.318	1396.180
01+600	1397.726	1396.284	1397.614
01+700	1397.693	1396.251	1397.948
01+800	1397.659	1396.218	1397.998
01+900	1397.626	1396.184	1396.163
02+000	1397.593	1396.151	1392.000
02+100	1397.559	1396.118	1397.789
02+200	1397.526	1396.084	1396.475
02+300	1397.493	1396.051	1395.836
02+400	1397.459	1396.018	1396.251
02+500	1397.426	1395.984	1396.762
02+600	1397.393	1395.951	1396.857
02+632	1396.866	1395.823	1396.155
02+661	1396.722	1395.707	1395.972
02+700	1396.566	1395.551	1395.890
02+800	1396.166 / 1394.166	1395.151 / 1393.151	1395.370
02+900	1393.766	1392.751	1393.540
03+000	1393.366 / 1391.366	1392.351 / 1390.351	1391.575

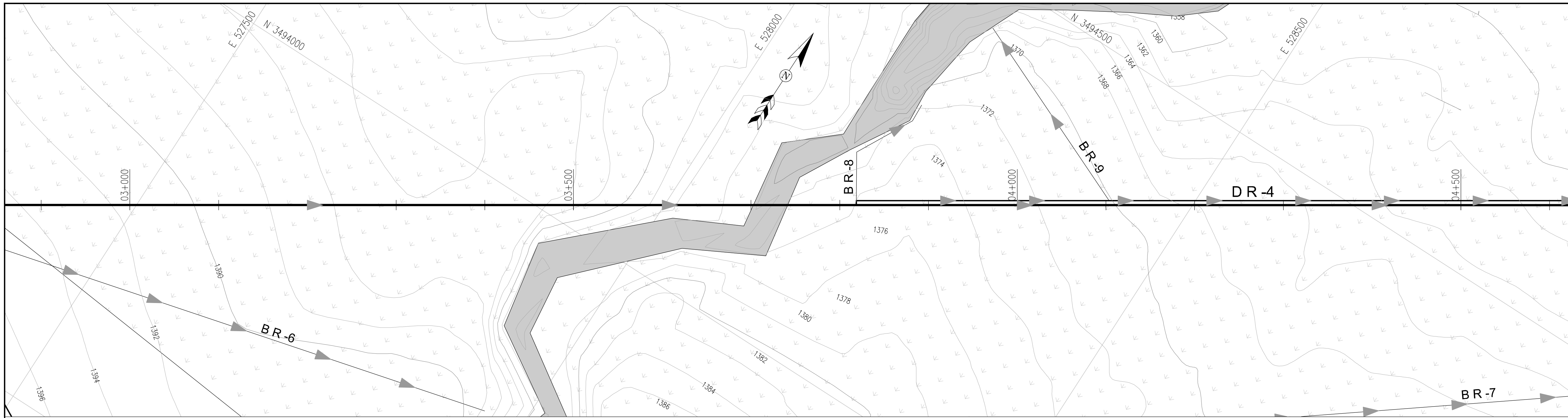
HORIZONTAL
0 50 100 200
m

VERTICAL (PROFILE)
0 5 10 20
m

CLIENT: ADB ASIAN DEVELOPMENT BANK	CONSTRUCTION SUPERVISION: Techno-Consult International (Pvt.)Ltd.	PROJECT: BALOCHISTAN WATER RESOURCES DEVELOPMENT PROJECT (TA)	DRAWING TITLE: RIGHT CHANNEL PLAN & PROFILE AT 1+500 TO 3+000	
		SCHEME: SIRI TOI DAM ZHOB RIVER BASIN		

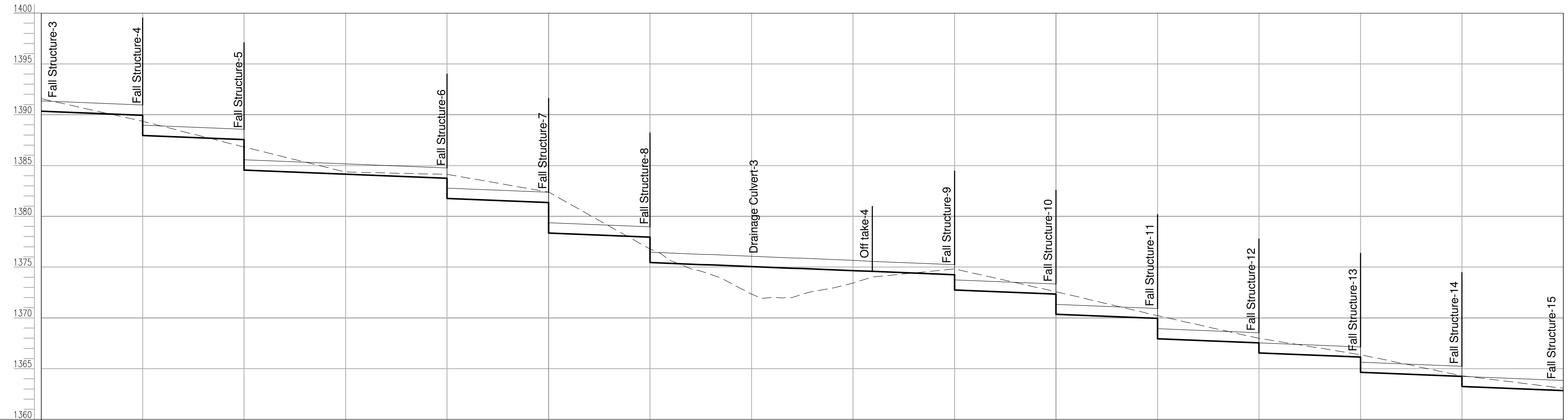
Designed By :	SAAD-UR-REHMAN	Date :	NOVEMBER 2017
Drawn By :	ARSALAN RAFAT	Scale :	AS SHOWN
Checked By :	ZAFAR MASOOD SIDDIQUE	Drg No :	
Approved By :	DR BASHIR LAKHANI		BWRDP-ZRB-STD-PP-504

No.	Revision	By	Date



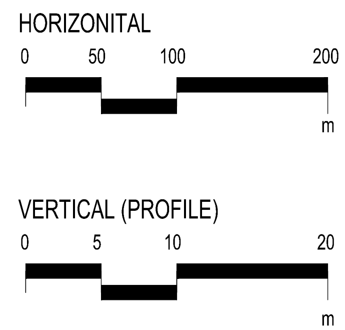
NOTE:
1. ALL DIMENSIONS & LEVELS ARE IN METER.

LEGEND:
- MAIN CANAL
- DR-1 DISTRIBUTARY CANAL
- BR-1 BRANCH CANAL
- ROAD
- 1400 CONTOUR
- RIVER
- STREAM
- COMMAND AREA
- SETTLEMENTS
- FALL STRUCTURE



DATUM	03+000 to 03+800	03+800 to 04+500
BED SLOPE	0.0040	0.0040
VELOCITY	1.87	1.81
DESIGN FLOW (CUMECS)	1.22	1.07
CANAL TYPE	TRAPEZOIDAL	TRAPEZOIDAL
BED WIDTH, B (m)	0.75	0.75
CANAL DEPTH, D (m)	1.02	0.98

DISTANCE (m)	BTL (m)	DBL (m)	NSL (m)
03+000	1393.366 / 1391.366	1392.351 / 1390.351	1391.575
03+100	1390.966 / 1388.966	1389.951 / 1387.951	1389.356
03+200	1388.566 / 1385.566	1387.551 / 1384.551	1386.819
03+300	1385.166	1384.151	1384.358
03+400	1384.766 / 1382.766	1383.751 / 1381.751	1384.131
03+500	1382.366 / 1379.366	1381.351 / 1378.351	1382.381
03+600	1378.966 / 1376.466	1377.951 / 1375.451	1376.776
03+700	1376.066	1375.051	1372.343
03+800	1375.666	1374.651	1373.421
03+819	1375.556	1374.575	1374.019
03+900	1375.232 / 1373.732	1374.251 / 1372.751	1374.821
04+000	1373.332 / 1371.332	1372.351 / 1370.351	1372.575
04+100	1370.932 / 1368.932	1369.951 / 1367.951	1370.219
04+200	1368.532 / 1367.532	1367.551 / 1366.551	1367.985
04+300	1367.132 / 1365.632	1366.151 / 1364.651	1366.379
04+400	1365.232 / 1364.232	1364.251 / 1363.251	1364.295
04+500	1363.832 / 1362.332	1362.851 / 1361.351	1363.075



CLIENT : ADB ASIAN DEVELOPMENT BANK

CONSTRUCTION SUPERVISION: Techno-Consult International (Pvt.)Ltd.

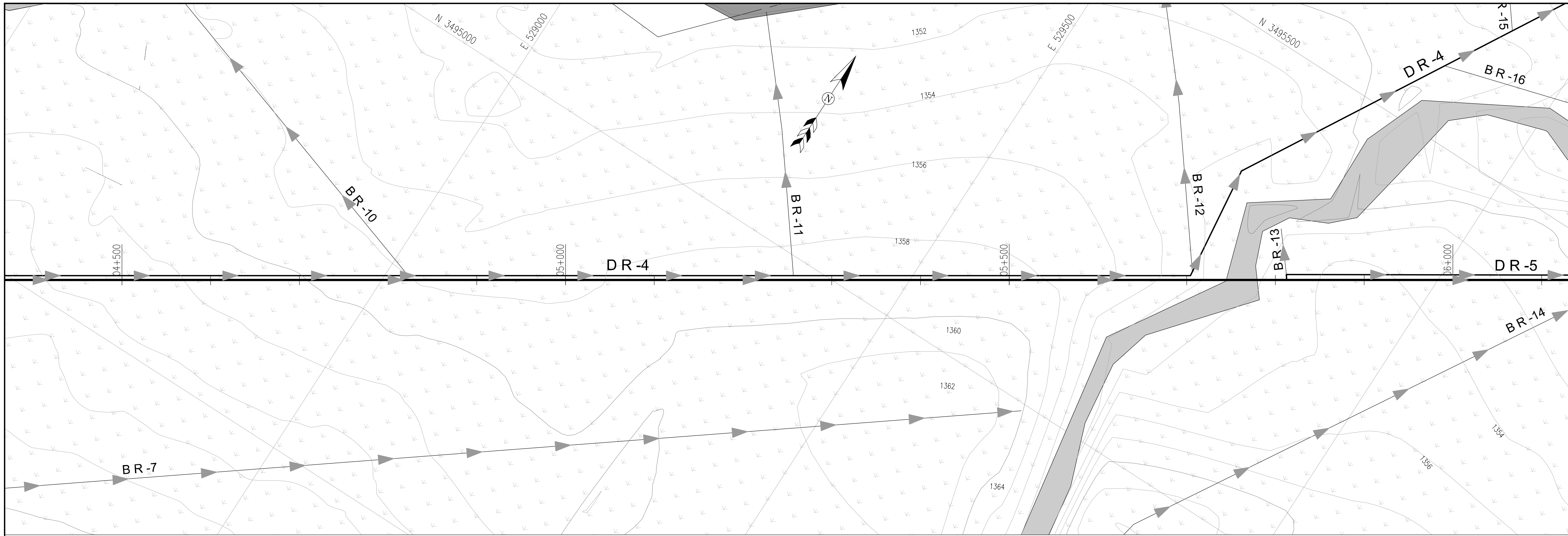
PROJECT: BALOCHISTAN WATER RESOURCES DEVELOPMENT PROJECT (TA)

SCHEME: SIRI TOI DAM ZHOB RIVER BASIN

DRAWING TITLE : RIGHT CHANNEL PLAN & PROFILE AT 3+000 TO 4+500

Designed By :	SAAD-UR-REHMAN	Date :	NOVEMBER 2017
Drawn By :	ARSALAN RAFAT	Scale :	AS SHOWN
Checked By :	ZAFAR MASOOD SIDDIQUE	Drg No :	
Approved By :	DR BASHIR LAKHANI		BWRDP-ZRB-STD-PP-505

No.	Revision	By	Date



NOTE:
1. ALL DIMENSIONS & LEVELS ARE IN METER.

LEGEND:

- MAIN CANAL
- DR-1 DISTRIBUTARY CANAL
- BR-1 BRANCH CANAL
- ROAD
- 1400 CONTOUR
- RIVER
- STREAM
- COMMAND AREA
- SETTLEMENTS
- FALL STRUCTURE

DATUM

BED SLOPE	0.0040	0.0005	0.0005	0.0005	0.0033
VELOCITY	1.81	0.83	1.11	1.65	
DESIGN FLOW (CUMECS)	1.07	0.97			
CANAL TYPE	TRAPEZOIDAL				
BED WIDTH, B (m)	0.75	1.00	0.75		
CANAL DEPTH, D (m)	0.98	1.24	0.98		

DISTANCE (m)	BTL (m)	DBL (m)	NSL (m)
04+500	1363.832 / 1362.332	1362.851 / 1361.351	1363.075
04+600	1361.932 / 1360.932	1360.951 / 1359.951	1361.319
04+700	1360.532 / 1359.532	1359.551 / 1358.551	1360.128
04+800	1359.132	1358.151	1358.592
04+900	1359.341	1358.101	1357.521
05+000	1359.291	1358.051	1357.539
05+100	1359.241	1358.001	1358.565
05+200	1359.191	1357.951	1358.837
05+300	1359.141	1357.901	1359.010
05+400	1359.091	1357.851	1359.021
05+500	1359.041 / 1358.041	1357.801 / 1356.801	1358.706
05+600	1357.991 / 1355.991	1356.751 / 1354.751	1356.067
05+700	1355.941	1354.701	1352.546
05+800	1355.627	1354.623	1352.460
05+813	1355.559	1354.579	1352.833
05+900	1355.269 / 1352.269	1354.289 / 1351.289	1354.027
06+000	1351.935	1350.956	1352.922

HORIZONITAL

0 50 100 200

m

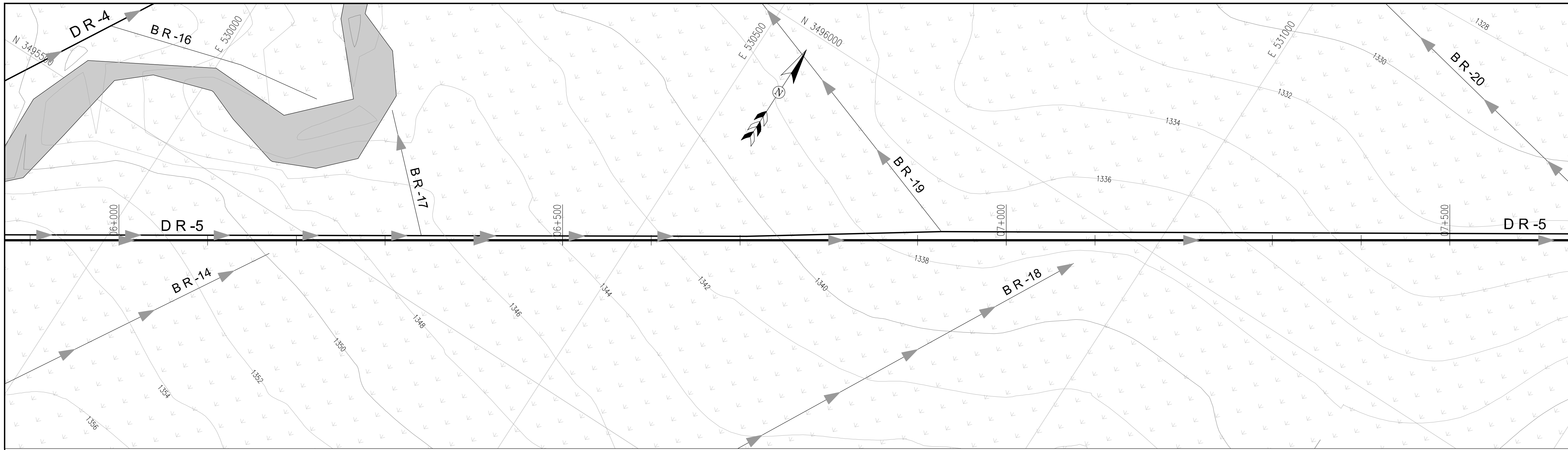
VERTICAL (PROFILE)

0 5 10 20

m

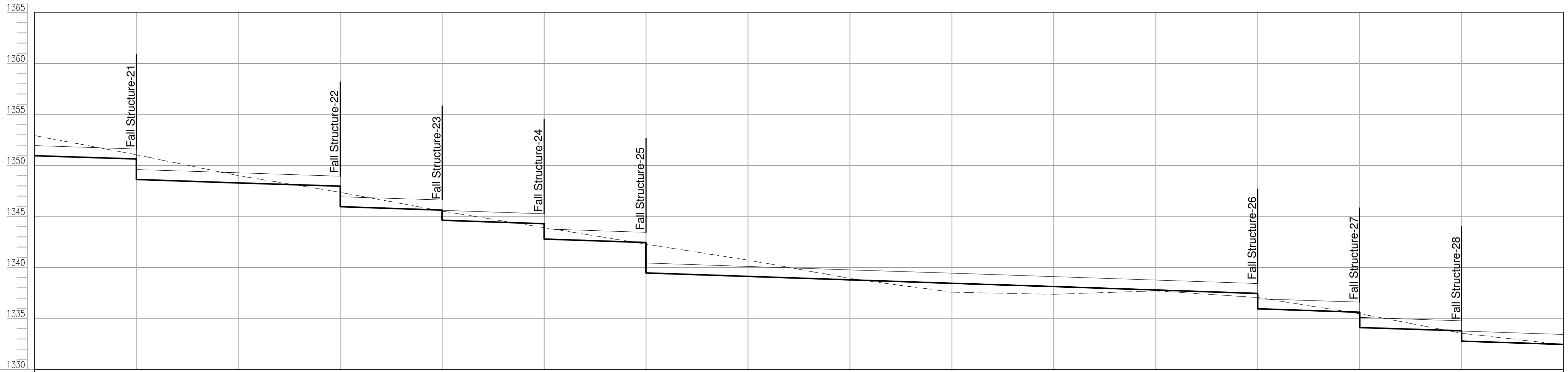
CLIENT:	CONSTRUCTION SUPERVISION:	PROJECT:	DRAWING TITLE:				
ASIAN DEVELOPMENT BANK	Techno-Consult International (Pvt.)Ltd.	BALOCHISTAN WATER RESOURCES DEVELOPMENT PROJECT (TA)	RIGHT CHANNEL PLAN & PROFILE AT 4+500 TO 6+000	Designed By :	SAAD-UR-REHMAN	Date :	NOVEMBER 2017
		SCHEME: SIRI TOI DAM ZHOB RIVER BASIN		Drawn By :	ARSALAN RAFAT	Scale :	AS SHOWN
				Checked By :	ZAFAR MASOOD SIDDIQUE	Drg No :	
				Approved By :	DR BASHIR LAKHANI		BWRDP-ZRB-STD-PP-506

No.	Revision	By	Date



NOTE:
1. ALL DIMENSIONS & LEVELS ARE IN METER.

LEGEND:
- MAIN CANAL
- DR-1 DISTRIBUTARY CANAL
- BR-1 BRANCH CANAL
- ROAD
- 1400 CONTOUR
- RIVER
- STREAM
- COMMAND AREA
- SETTLEMENTS
- FALL STRUCTURE



DATUM	
BED SLOPE	0.0033
VELOCITY	1.65
DESIGN FLOW (CUMECS)	0.97
CANAL TYPE	TRAPEZOIDAL
BED WIDTH, B (m)	0.75
CANAL DEPTH, D (m)	0.98

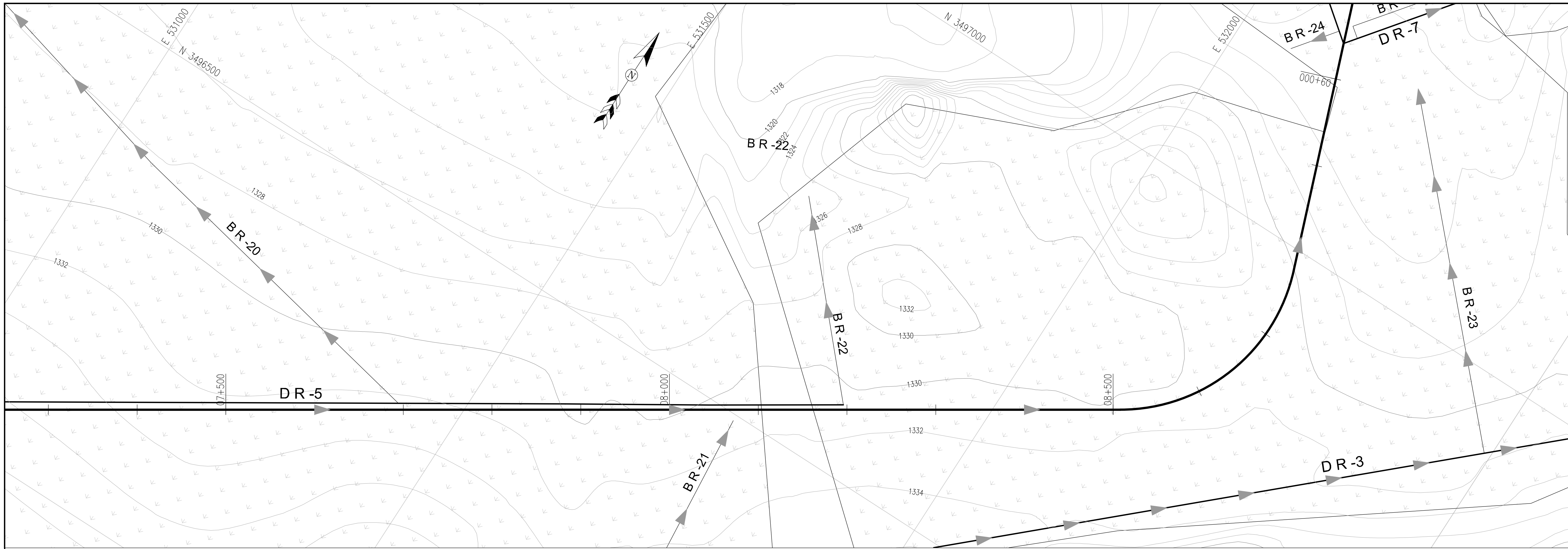
DISTANCE (m)	NSL (m)	DBL (m)	BTL (m)
06+000	1352.922	1350.956	1351.935
06+100	1351.039	1350.623 / 1348.623	1351.602 / 1349.602
06+200	1348.995	1348.289	1349.269
06+300	1347.367	1347.956 / 1345.956	1348.935 / 1346.935
06+400	1345.522	1345.623 / 1344.623	1346.602 / 1345.602
06+500	1343.905	1344.289 / 1342.789	1345.269 / 1343.769
06+600	1342.284	1342.456 / 1339.456	1343.435 / 1340.435
06+700	1340.722	1339.123	1340.102
06+800	1338.927	1338.789	1339.769
06+900	1337.573	1338.456	1339.435
07+000	1337.375	1338.123	1339.102
07+100	1337.703	1337.789	1338.769
07+200	1337.053	1337.456 / 1335.956	1338.435 / 1336.935
07+300	1335.471	1335.623 / 1334.123	1336.602 / 1335.102
07+400	1333.559	1333.789 / 1332.789	1334.769 / 1333.769
07+500	1332.424	1332.456	1333.435

HORIZONITAL
0 50 100 200 m

VERTICAL (PROFILE)
0 5 10 20 m

CLIENT:	CONSTRUCTION SUPERVISION:	PROJECT:	DRAWING TITLE:				
ADB ASIAN DEVELOPMENT BANK	Techno-Consult International (Pvt.)Ltd.	BALOCHISTAN WATER RESOURCES DEVELOPMENT PROJECT (TA) SCHEME: SIRI TOI DAM ZHOB RIVER BASIN	RIGHT CHANNEL PLAN & PROFILE AT 6+000 TO 7+500	Designed By :	SAAD-UR-REHMAN	Date :	NOVEMBER 2017
				Drawn By :	ARSALAN RAFAT	Scale :	AS SHOWN
				Checked By :	ZAFAR MASOOD SIDDIQUE	Drg No :	BWRDP-ZRB-STD-PP-507
				Approved By :	DR BASHIR LAKHANI		

No.	Revision	By	Date



NOTE:
1. ALL DIMENSIONS & LEVELS ARE IN METER.

LEGEND:

- MAIN CANAL
- DR-1 DISTRIBUTARY CANAL
- BR-1 BRANCH CANAL
- ROAD
- 1400 CONTOUR
- RIVER
- STREAM
- COMMAND AREA
- SETTLEMENTS
- FALL STRUCTURE

DATUM

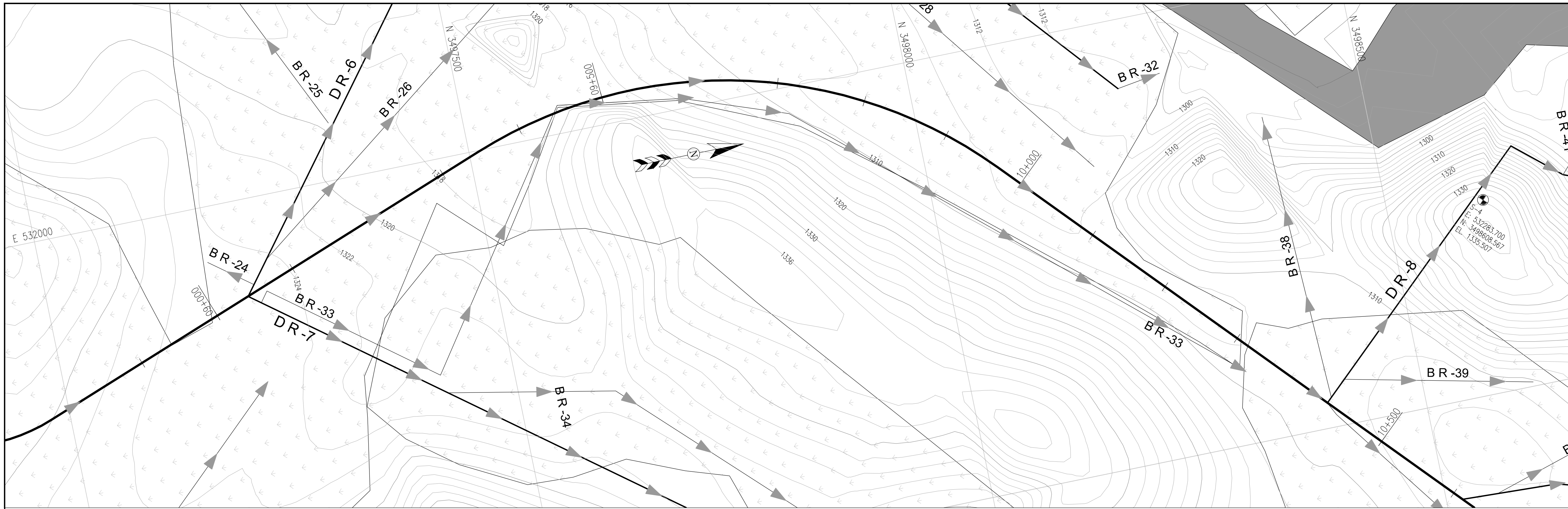
BED SLOPE	0.0033				0.0005			0.0005						0.0020						
VELOCITY	1.65				0.81									1.36						
DESIGN FLOW (CUMECS)	0.97																			
CANAL TYPE	TRAPEZOIDAL																			
BED WIDTH, B (m)	0.75				1.00									0.75						
CANAL DEPTH, D (m)	0.98				1.20									1.05						
BTL (m)	1333.435	1333.102	1332.769	1332.435	1332.609	1332.559	1332.509	1332.459	1332.409	1332.359	1332.309	1332.259	1331.904	1331.154	1330.954	1327.954	1327.754	1326.754	1326.554	
DBL (m)	1332.456	1332.123	1331.789	1331.456	1331.406	1331.356	1331.306	1331.256	1331.206	1331.156	1331.106	1331.056	1330.856	1330.106	1329.906	1326.906	1326.706	1325.706	1325.506	
NSL (m)	1332.424	1332.683	1332.586	1331.727	1329.974	1329.794	1331.124	1330.863	1331.098	1330.709	1330.512	1330.738	1330.752		1329.512		1326.668		1325.303	
DISTANCE (m)	07+500	07+600	07+700	07+800	07+900	08+000	08+100	08+200	08+300	08+400	08+500	08+600	08+700		08+800		08+900		09+000	

HORIZONTAL
0 50 100 200
m

VERTICAL (PROFILE)
0 5 10 20
m

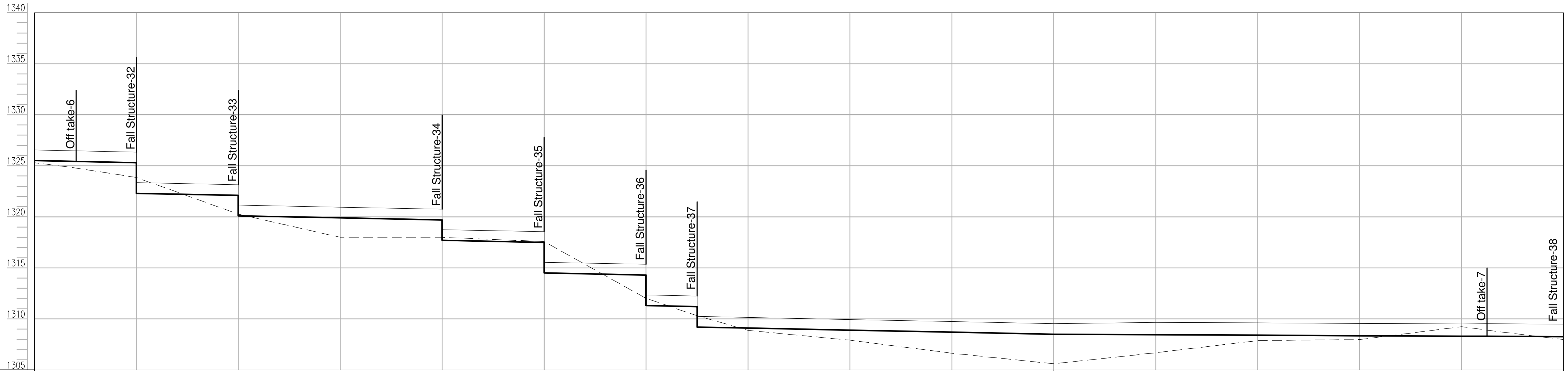
CLIENT : ASIAN DEVELOPMENT BANK	CONSTRUCTION SUPERVISION: Techno-Consult International (Pvt.) Ltd.	PROJECT: BALOCHISTAN WATER RESOURCES DEVELOPMENT PROJECT (TA)	DRAWING TITLE : RIGHT CHANNEL PLAN & PROFILE AT 7+500 TO 9+000	Designed By : SAAD-UR-REHMAN	Date : NOVEMBER 2017
		SCHEME: SIRI TOI DAM ZHOB RIVER BASIN		Drawn By : ARSALAN RAFAT	Scale : AS SHOWN
				Checked By : ZAFAR MASOOD SIDDIQUE	Drg No : BWRDP-ZRB-STD-PP-508
				Approved By : DR BASHIR LAKHANI	

No.	Revision	By	Date



NOTE:
1. ALL DIMENSIONS & LEVELS ARE IN METER.

LEGEND:
- MAIN CANAL
- DR-1 DISTRIBUTARY CANAL
- BR-1 BRANCH CANAL
- ROAD
- 1400 CONTOUR
- RIVER
- STREAM
- COMMAND AREA
- SETTLEMENTS
- FALL STRUCTURE



DATUM

Parameter	09+000 to 10+000	10+000 to 10+400	10+400 to 10+500
BED SLOPE	0.0020	0.0005	0.0005
VELOCITY	1.36	0.79	0.77
DESIGN FLOW (CUMECS)	0.95	0.95	0.85
CANAL TYPE	TRAPEZOIDAL	TRAPEZOIDAL	TRAPEZOIDAL
BED WIDTH, B (m)	0.75	1.00	0.75
CANAL DEPTH, D (m)	1.04	1.20	1.24

DISTANCE (m)	NSL (m)	DBL (m)	BTL (m)
09+000	1325.303	1325.506	1326.554
09+041	1324.780	1325.424	1326.466
09+100	1323.859	1325.306 / 1322.306	1326.348 / 1323.348
09+200	1320.266	1322.106 / 1320.106	1323.148 / 1321.148
09+300	1318.000	1319.906	1320.948
09+400	1317.999	1319.706 / 1317.706	1320.748 / 1318.748
09+500	1317.581	1317.506 / 1314.506	1318.548 / 1315.548
09+600	1312.017	1314.306 / 1311.306	1315.348 / 1312.348
	1310.331	1311.206 / 1309.206	1312.248 / 1310.248
09+700	1308.882	1309.106	1310.148
09+800	1307.924	1308.906	1309.948
09+900	1306.647	1308.706	1309.748
10+000	1305.614	1308.506	1309.548
10+100	1306.691	1308.458	1309.663
10+200	1307.887	1308.411	1309.615
10+300	1307.987	1308.363	1309.568
10+400	1309.245	1308.316	1309.520
10+425	1308.906	1308.304	1309.542
10+500	1307.983	1308.268 / 1306.268	1309.507 / 1307.507

HORIZONITAL
0 50 100 200 m

VERTICAL (PROFILE)
0 5 10 20 m

CLIENT :
ASIAN DEVELOPMENT BANK

CONSTRUCTION SUPERVISION:
Techno-Consult International (Pvt.)Ltd.

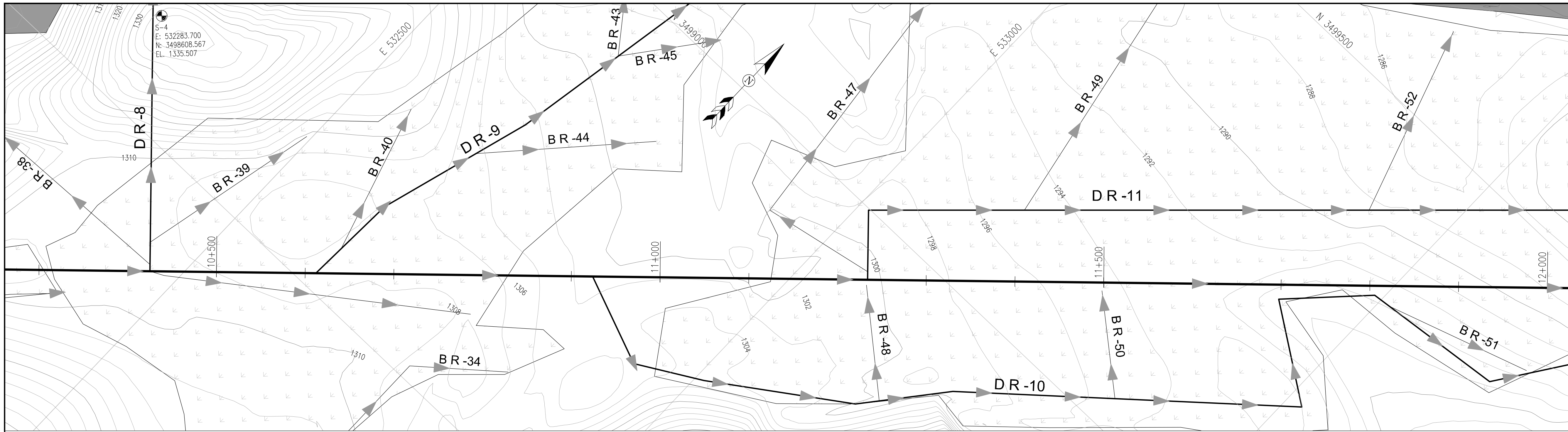
PROJECT:
BALOCHISTAN WATER RESOURCES DEVELOPMENT PROJECT (TA)

SCHEME:
SIRI TOI DAM
ZHOB RIVER BASIN

DRAWING TITLE :
RIGHT CHANNEL
PLAN & PROFILE
AT 9+000 TO 10+500

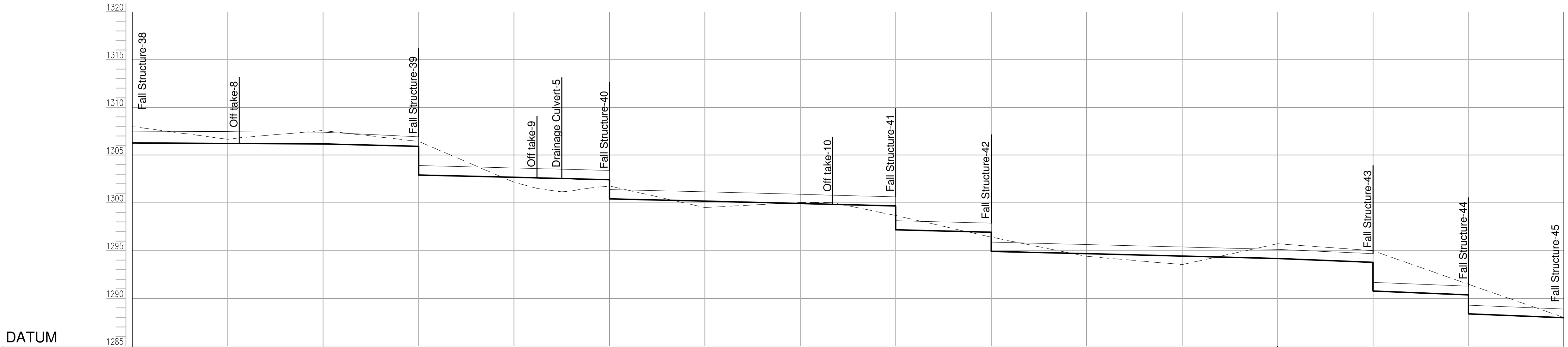
Designed By :	SAAD-UR-REHMAN	Date :	NOVEMBER 2017
Drawn By :	ARSALAN RAFAT	Scale :	AS SHOWN
Checked By :	ZAFAR MASOOD SIDDIQUE	Drg No :	
Approved By :	DR BASHIR LAKHANI		BWRDP-ZRB-STD-PP-509

No.	Revision	By	Date



NOTE:
1. ALL DIMENSIONS & LEVELS ARE IN METER.

LEGEND:
- MAIN CANAL
- DR-1 DISTRIBUTARY CANAL
- BR-1 BRANCH CANAL
- ROAD
- CONTOUR (1400)
- RIVER
- STREAM
- COMMAND AREA
- SETTLEMENTS
- FALL STRUCTURE



DATUM

Item	10+500 – 10+700	10+700 – 11+700	11+700 – 12+000
BED SLOPE	0.0005	0.0025	0.0040

Item	Values
VELOCITY	0.77 (10+500 – 10+700); 1.43 (10+700 – 10+900); 1.42 (10+900 – 11+200); 1.40 (11+200 – 11+700); 1.66 (11+700 – 12+000)
DESIGN FLOW (CUMECS)	0.85 (10+500 – 10+600); 0.84 (10+600 – 10+900); 0.83 (10+900 – 11+200); 0.78 (11+200 – 12+000)
CANAL TYPE	TRAPEZOIDAL
BED WIDTH, B (m)	0.75
CANAL DEPTH, D (m)	1.24 (10+500 – 10+600); 1.23 (10+600 – 10+700); 0.98 (10+700 – 11+200); 0.96 (11+200 – 11+700); 0.91 (11+700 – 12+000)

DISTANCE (m)	NSL (m)	DBL (m)	BTL (m)
10+500	1307.983	1308.268 / 1306.268	1309.507 / 1307.507
10+600	1306.657	1306.220	1307.459
10+612	1306.814	1306.215	1307.449
10+700	1307.569	1306.173	1307.407
10+800	1306.434	1305.923 / 1302.923	1306.902 / 1303.902
10+900	1302.163	1302.673	1303.652
10+924	1301.521	1302.613	1303.589
11+000	1301.762	1302.423 / 1300.423	1303.399 / 1301.399
11+100	1299.508	1300.173	1301.149
11+200	1300.043	1299.923	1300.899
11+234	1300.022	1299.838	1300.798
11+300	1298.671	1299.673 / 1297.173	1300.633 / 1298.133
11+400	1296.408	1296.923 / 1294.923	1297.883 / 1295.883
11+500	1294.397	1294.673	1295.633
11+600	1293.538	1294.423	1295.383
11+700	1295.716	1294.173	1295.133
11+800	1294.990	1293.773 / 1290.773	1294.679 / 1291.679
11+900	1291.480	1290.373 / 1288.373	1291.279 / 1289.279
12+000	1287.991	1287.973 / 1286.973	1288.879 / 1287.879

HORIZONTAL
0 50 100 200
m

VERTICAL (PROFILE)
0 5 10 20
m

CLIENT :
ADB
ASIAN DEVELOPMENT BANK

CONSTRUCTION SUPERVISION:
Techno-Consult International (Pvt.)Ltd.

PROJECT:
BALOCHISTAN WATER RESOURCES DEVELOPMENT PROJECT (TA)

SCHEME:
SIRI TOI DAM
ZHOB RIVER BASIN

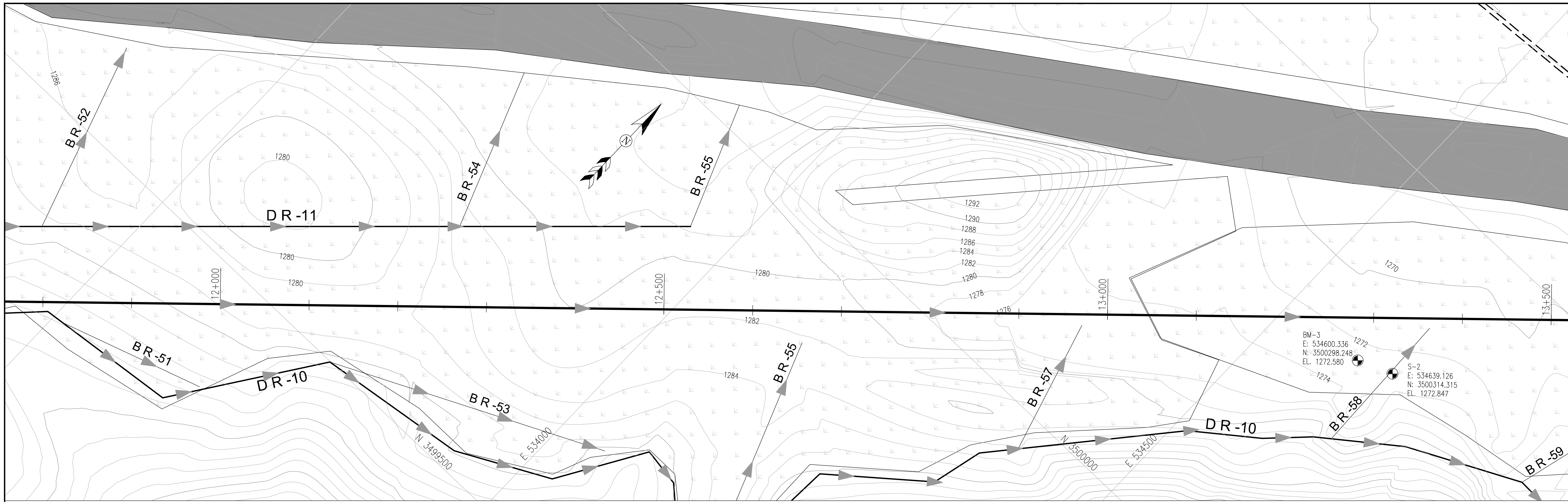
DRAWING TITLE :
RIGHT CHANNEL
PLAN & PROFILE
AT 10+500 TO 12+000

Designed By :	SAAD-UR-REHMAN	Date :	NOVEMBER 2017
Drawn By :	ARSALAN RAFAT	Scale :	AS SHOWN
Checked By :	ZAFAR MASOOD SIDDIQUE	Drg No :	
Approved By :	DR BASHIR LAKHANI		BWRDP-ZRB-STD-PP-510

No.	Revision	By	Date

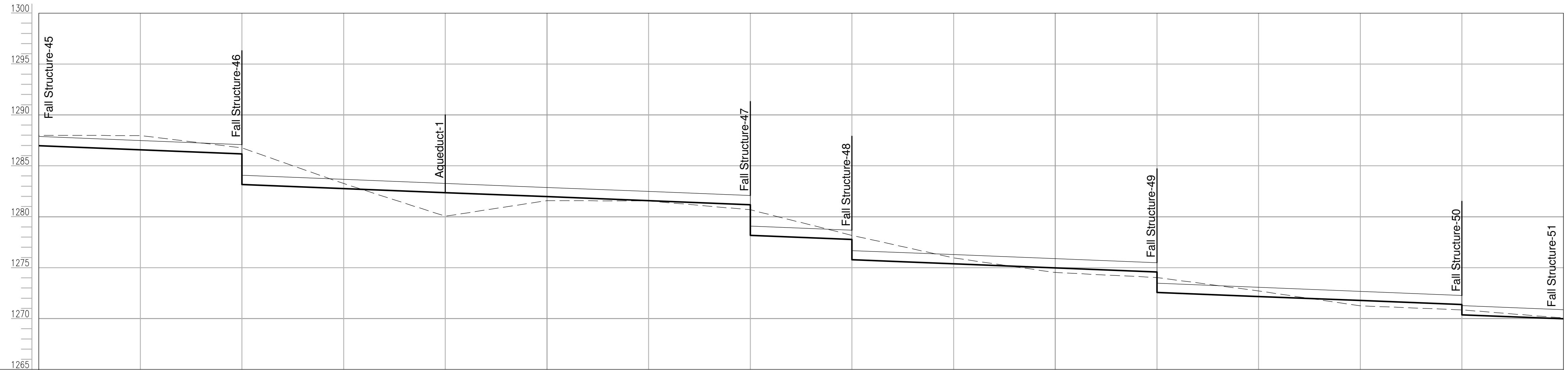
NOTE:

1. ALL DIMENSIONS & LEVELS ARE IN METER.



LEGEND:

- MAIN CANAL
- DR-1 DISTRIBUTARY CANAL
- BR-1 BRANCH CANAL
- ROAD
- CONTOUR
- RIVER
- STREAM
- COMMAND AREA
- SETTLEMENTS
- FALL STRUCTURE



DATUM

BED SLOPE	0.0040
VELOCITY	1.66
DESIGN FLOW (CUMECS)	0.78
CANAL TYPE	TRAPEZOIDAL
BED WIDTH, B (m)	0.75
CANAL DEPTH, D (m)	0.91

DISTANCE (m)	BTL (m)	DBL (m)	NSL (m)
12+000	1288.879 / 1287.879	1287.973 / 1286.973	1287.991
12+100	1287.479	1286.573	1287.976
12+200	1287.079 / 1284.079	1286.173 / 1283.173	1286.756
12+300	1283.679	1282.773	1283.262
12+400	1283.279	1282.373	1280.050
12+500	1282.879	1281.973	1281.586
12+600	1282.479	1281.573	1281.549
12+700	1282.079 / 1279.079	1281.173 / 1278.173	1280.688
12+800	1278.679 / 1276.679	1277.773 / 1275.773	1278.173
12+900	1276.279	1275.373	1275.957
13+000	1275.879	1274.973	1274.523
13+100	1275.479 / 1273.479	1274.573 / 1272.573	1274.035
13+200	1273.079	1272.173	1272.712
13+300	1272.679	1271.773	1271.256
13+400	1272.279 / 1271.279	1271.373 / 1270.373	1270.854
13+500	1270.879 / 1268.879	1269.973 / 1267.973	1270.057

HORIZONTAL

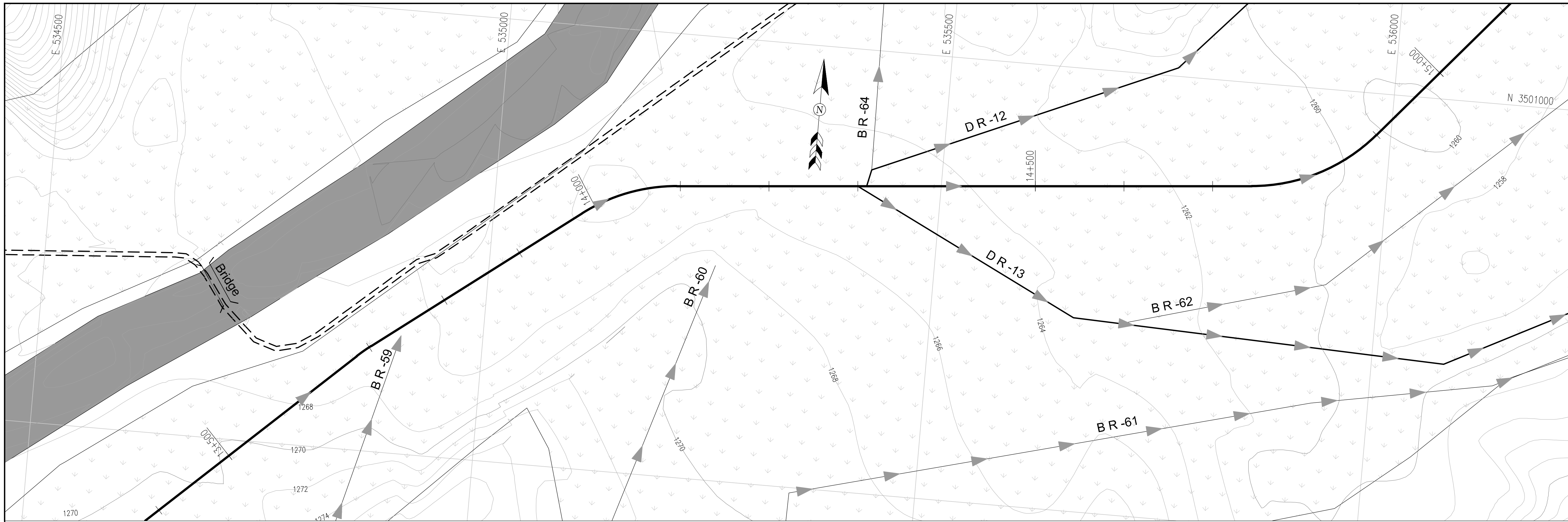
0 50 100 200 m

VERTICAL (PROFILE)

0 5 10 20 m

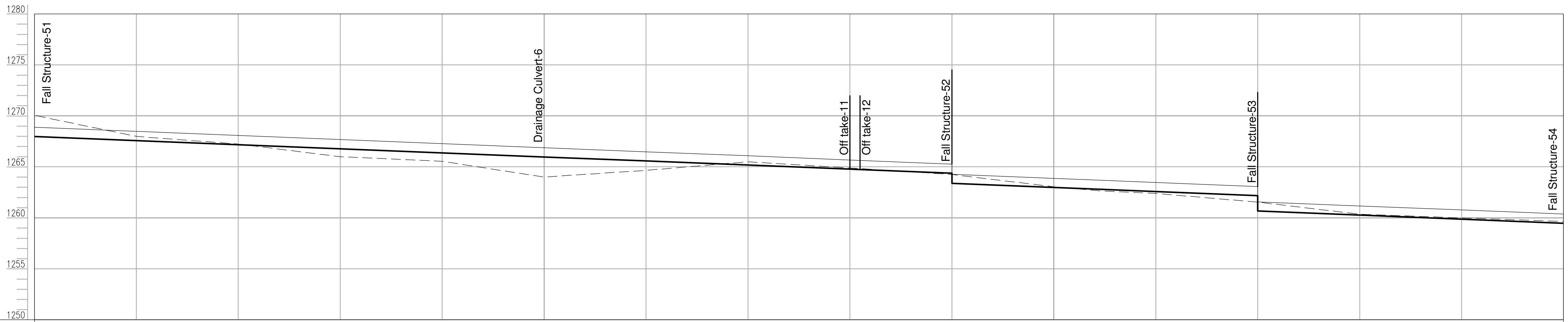
CLIENT :	ASIAN DEVELOPMENT BANK
CONSTRUCTION SUPERVISION:	Techno-Consult International (Pvt.)Ltd.
PROJECT:	BALOCHISTAN WATER RESOURCES DEVELOPMENT PROJECT (TA)
SCHEME:	SIRI TOI DAM ZHOB RIVER BASIN
DRAWING TITLE :	RIGHT CHANNEL PLAN & PROFILE AT 12+000 TO 13+500
Designed By :	SAAD-UR-REHMAN
Drawn By :	ARSALAN RAFAT
Checked By :	ZAFAR MASOOD SIDDIQUE
Approved By :	DR BASHIR LAKHANI
Date :	NOVEMBER 2017
Scale :	AS SHOWN
Drg No :	BWRDP-ZRB-STD-PP-511

No.	Revision	By	Date



NOTE:
1. ALL DIMENSIONS & LEVELS ARE IN METER.

LEGEND:
- MAIN CANAL
- DR-1 DISTRIBUTARY CANAL
- BR-1 BRANCH CANAL
- ROAD
- 1400 CONTOUR
- RIVER
- STREAM
- COMMAND AREA
- SETTLEMENTS
- FALL STRUCTURE



DATUM

	13+500 to 14+300	14+310 to 15+000
BED SLOPE	0.0040	0.0040
VELOCITY	1.66	1.64
DESIGN FLOW (CUMECS)	0.78	0.75
CANAL TYPE	TRAPEZOIDAL	TRAPEZOIDAL
BED WIDTH, B (m)	0.75	0.75
CANAL DEPTH, D (m)	0.91	0.90

DISTANCE (m)	BTL (m)	DBL (m)	NSL (m)
13+500	1270.879 1268.879	1269.973 1267.973	1270.057
13+600	1268.479	1267.573	1267.985
13+700	1268.079	1267.173	1267.238
13+800	1267.679	1266.773	1265.990
13+900	1267.279	1266.373	1265.539
14+000	1266.879	1265.973	1264.000
14+100	1266.479	1265.573	1264.653
14+200	1266.079	1265.173	1265.499
14+300	1265.674	1264.773	1264.891
14+310	1265.630	1264.733	
14+400	1265.270 1264.271	1264.373 1263.373	1264.248
14+500	1263.870	1262.973	1263.050
14+543	1263.698	1262.801	1262.663
14+600	1263.470	1262.573	1262.393
14+700	1263.070 1261.570	1262.173 1260.673	1261.541
14+800	1261.170	1260.273	1260.357
14+900	1260.770	1259.873	1259.998
15+000	1260.370 1259.370	1259.473 1258.473	1259.646

HORIZONTAL
0 50 100 200
m

VERTICAL (PROFILE)
0 5 10 20
m

CLIENT :
ADB ASIAN DEVELOPMENT BANK

CONSTRUCTION SUPERVISION:
Techno-Consult International (Pvt.)Ltd.

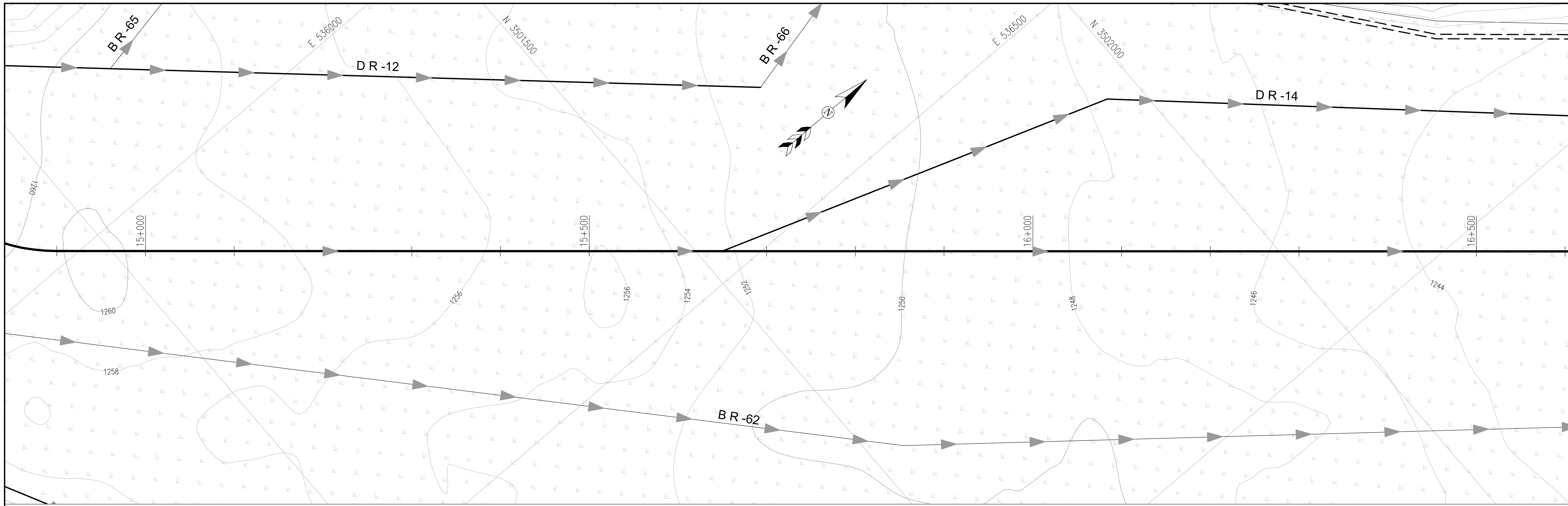
PROJECT:
BALOCHISTAN WATER RESOURCES DEVELOPMENT PROJECT (TA)

SCHEME:
SIRI TOI DAM
ZHOB RIVER BASIN

DRAWING TITLE :
RIGHT CHANNEL
PLAN & PROFILE
AT 13+500 TO 15+000

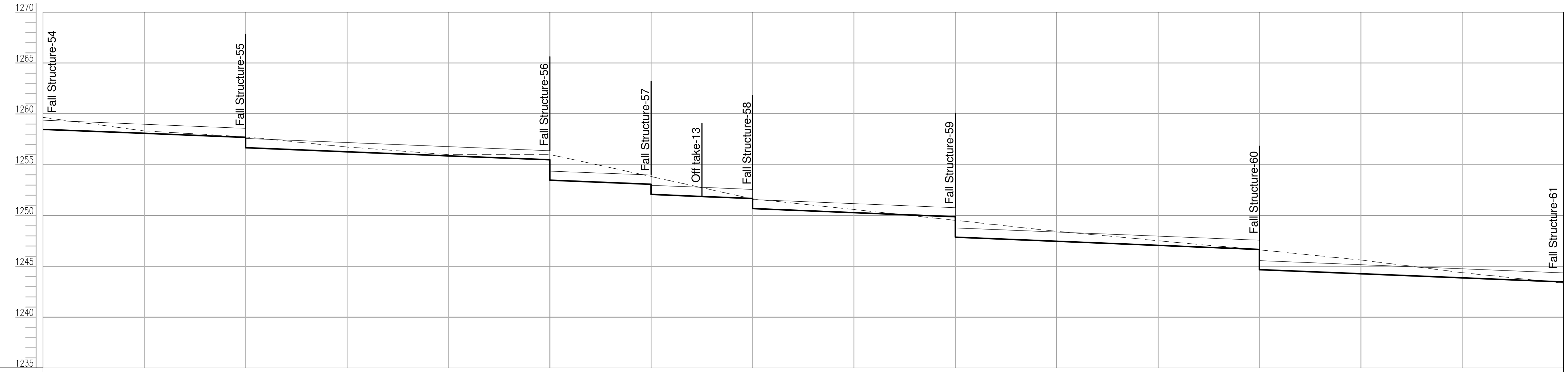
Designed By :	SAAD-UR-REHMAN	Date :	NOVEMBER 2017
Drawn By :	ARSALAN RAFAT	Scale :	AS SHOWN
Checked By :	ZAFAR MASOOD SIDDIQUE	Drg No :	
Approved By :	DR BASHIR LAKHANI		BWRDP-ZRB-STD-PP-512

No.	Revision	By	Date



NOTE:
1. ALL DIMENSIONS & LEVELS ARE IN METER.

LEGEND:
- MAIN CANAL
- DR-1 DISTRIBUTARY CANAL
- BR-1 BRANCH CANAL
- ROAD
- 1400 CONTOUR
- RIVER
- STREAM
- COMMAND AREA
- SETTLEMENTS
- FALL STRUCTURE



DATUM

BED SLOPE: 0.0040
VELOCITY: 1.64
DESIGN FLOW (CUMECS): 0.75 (15+000 to 15+600); 0.74 (15+600 to 16+500)
CANAL TYPE: TRAPEZOIDAL
BED WIDTH, B (m): 0.75
CANAL DEPTH, D (m): 0.90 (15+000 to 15+600); 0.89 (15+600 to 16+500)

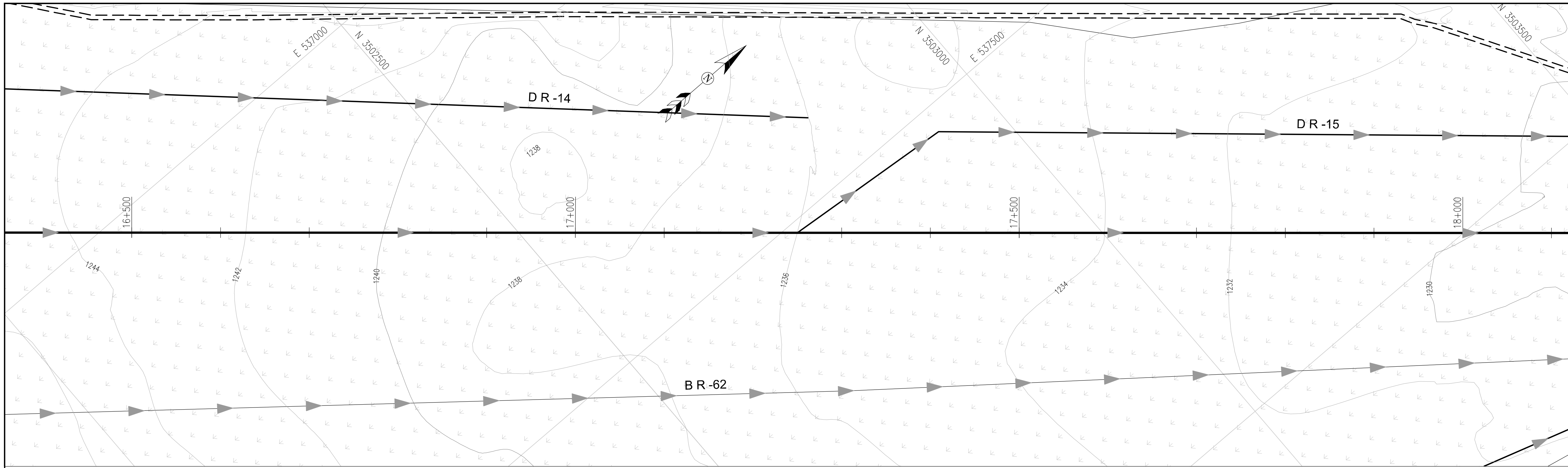
DISTANCE (m)	BTL (m)	DBL (m)	NSL (m)
15+000	1260.370 / 1259.370	1259.473 / 1258.473	1259.646
15+100	1258.970	1258.073	1258.318
15+200	1258.570 / 1257.570	1257.673 / 1256.673	1257.730
15+300	1257.170	1256.273	1256.733
15+400	1256.770	1255.873	1255.985
15+500	1256.370 / 1254.370	1255.473 / 1253.473	1255.994
15+600	1253.970 / 1252.970	1253.073 / 1252.073	1253.834
15+650	1252.767	1251.873	
15+700	1252.567 / 1251.567	1251.673 / 1250.673	1251.635
15+800	1251.167	1250.273	1250.591
15+900	1250.767 / 1248.767	1249.873 / 1247.873	1249.527
16+000	1248.367	1247.473	1248.447
16+100	1247.967	1247.073	1247.527
16+200	1247.567 / 1245.567	1246.673 / 1244.673	1246.625
16+300	1245.167	1244.273	1245.624
16+400	1244.767	1243.873	1244.385
16+500	1244.367 / 1242.367	1243.473 / 1241.473	1243.348

HORIZONTAL
0 50 100 200 m

VERTICAL (PROFILE)
0 5 10 20 m

CLIENT: ADB ASIAN DEVELOPMENT BANK	CONSTRUCTION SUPERVISION: Techno-Consult International (Pvt.)Ltd.	PROJECT: BALOCHISTAN WATER RESOURCES DEVELOPMENT PROJECT (TA) SCHEME: SIRI TOI DAM ZHOB RIVER BASIN	DRAWING TITLE: RIGHT CHANNEL PLAN & PROFILE AT 15+000 TO 16+500	Designed By: SAAD-UR-REHMAN Drawn By: ARSALAN RAFAT Checked By: ZAFAR MASOOD SIDDIQUE Approved By: DR BASHIR LAKHANI Date: NOVEMBER 2017 Scale: AS SHOWN Drg No: BWRDP-ZRB-STD-PP-513

No.	Revision	By	Date

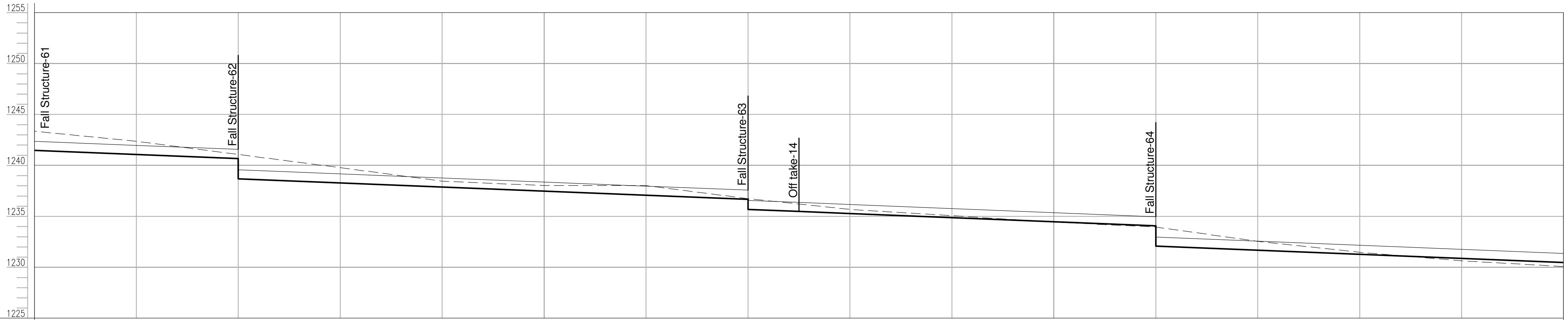


NOTE:

1. ALL DIMENSIONS & LEVELS ARE IN METER.

LEGEND:

- MAIN CANAL
- DR-1 DISTRIBUTARY CANAL
- BR-1 BRANCH CANAL
- ROAD
- 1400 CONTOUR
- RIVER
- STREAM
- COMMAND AREA
- SETTLEMENTS
- FALL STRUCTURE



DATUM

BED SLOPE	0.0040
VELOCITY	1.64 (16+500 to 17+200); 1.63 (17+200 to 18+000)
DESIGN FLOW (CUMECS)	0.74 (16+500 to 17+200); 0.73 (17+200 to 18+000)
CANAL TYPE	TRAPEZOIDAL
BED WIDTH, B (m)	0.75
CANAL DEPTH, D (m)	0.89

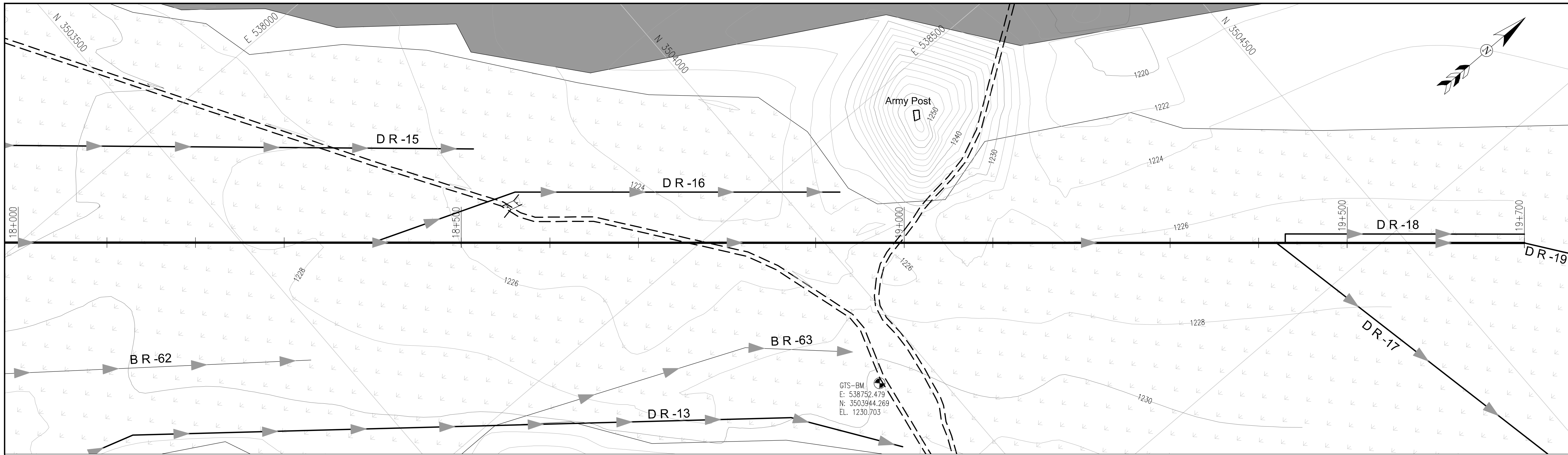
DISTANCE (m)	BTL (m)	DBL (m)	NSL (m)
16+500	1244.367 / 1242.367	1243.473 / 1241.473	1243.348
16+600	1241.967	1241.073	1242.365
16+700	1241.567 / 1239.567	1240.673 / 1238.673	1241.070
16+800	1239.167	1238.273	1239.775
16+900	1238.767	1237.873	1238.455
17+000	1238.367	1237.473	1238.017
17+100	1237.967	1237.073	1238.012
17+200	1237.567 / 1236.567	1236.673 / 1235.673	1236.736
17+250	1236.363	1235.473	
17+300	1236.163	1235.273	1235.676
17+400	1235.763	1234.873	1235.064
17+500	1235.363	1234.473	1234.426
17+600	1234.963 / 1232.963	1234.073 / 1232.073	1233.947
17+700	1232.563	1231.673	1232.546
17+800	1232.163	1231.273	1231.474
17+900	1231.763	1230.873	1230.635
18+000	1231.363	1230.473	1230.072

HORIZONTAL
0 50 100 200
m

VERTICAL (PROFILE)
0 5 10 20
m

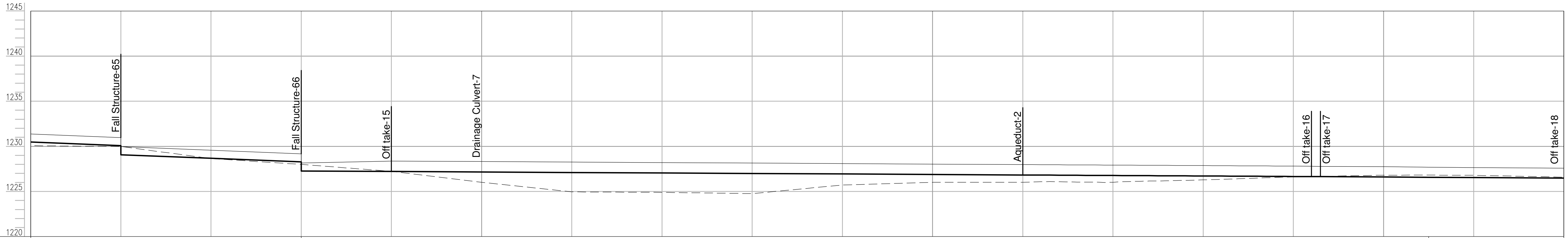
CLIENT : ADB ASIAN DEVELOPMENT BANK	CONSTRUCTION SUPERVISION: Techno-Consult International (Pvt.)Ltd.	PROJECT: BALOCHISTAN WATER RESOURCES DEVELOPMENT PROJECT (TA)	DRAWING TITLE : RIGHT CHANNEL PLAN & PROFILE AT 16+500 TO 18+000	Designed By : SAAD-UR-REHMAN	Date : NOVEMBER 2017
		SCHEME: SIRI TOI DAM ZHOB RIVER BASIN		Drawn By : ARSALAN RAFAT	Scale : AS SHOWN
				Checked By : ZAFAR MASOOD SIDDIQUE	Drg No :
				Approved By : DR BASHIR LAKHANI	BWRDP-ZRB-STD-PP-514

No.	Revision	By	Date



NOTE:
1. ALL DIMENSIONS & LEVELS ARE IN METER.

LEGEND:
- MAIN CANAL
- DR–1 DISTRIBUTARY CANAL
- BR–1 BRANCH CANAL
- ROAD
- 1400 CONTOUR
- RIVER
- STREAM
- COMMAND AREA
- SETTLEMENTS
- FALL STRUCTURE



DATUM

BED SLOPE	0.0040	0.0006	0.0007	
VELOCITY	1.63	0.78	0.77	0.83
DESIGN FLOW (CUMECS)	0.73	0.72	0.69	
CANAL TYPE	TRAPEZOIDAL			
BED WIDTH, B (m)	0.75			
CANAL DEPTH, D (m)	0.89	1.15	1.14	1.11

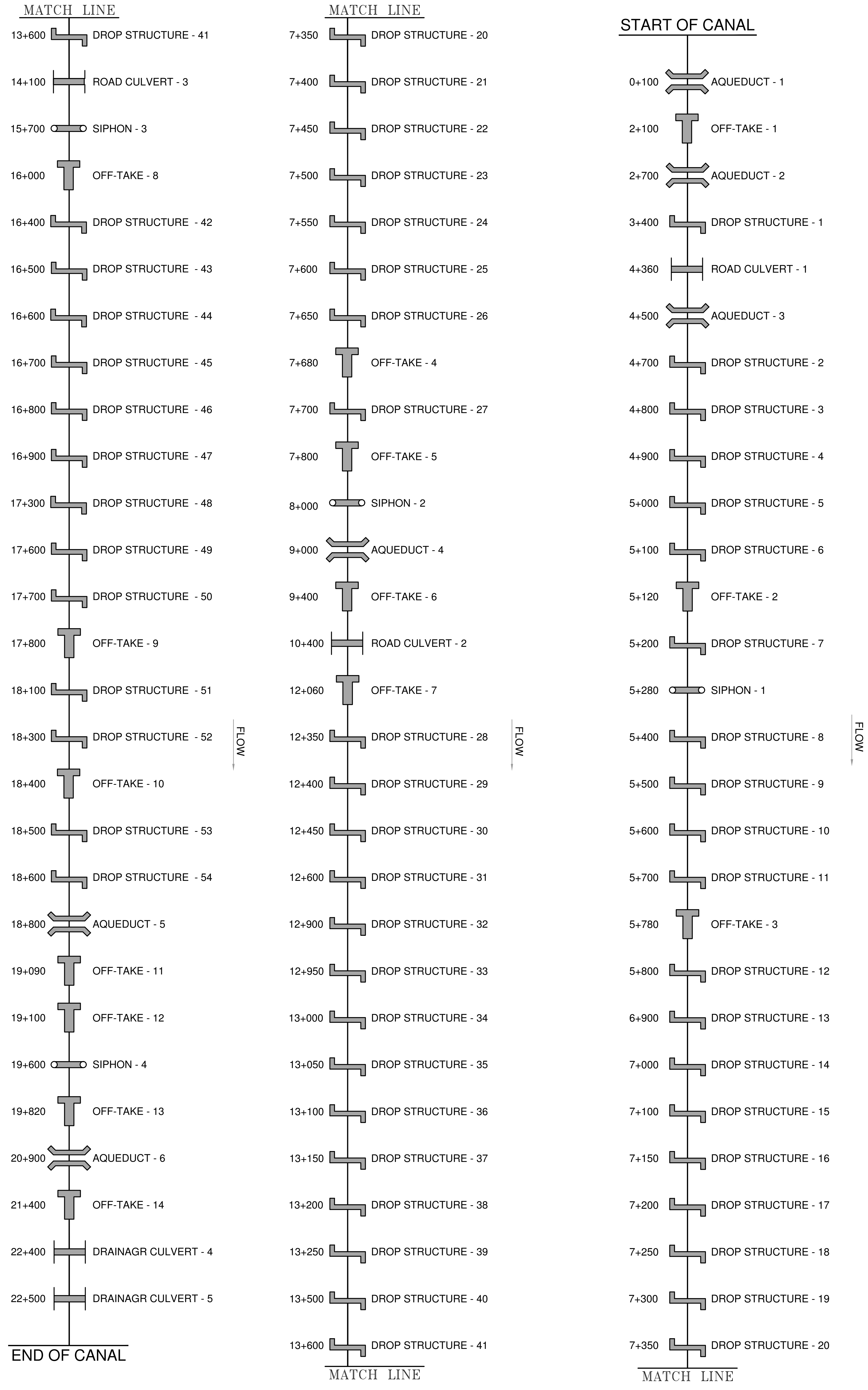
DISTANCE (m)	BTL (m)	DBL (m)	NSL (m)
18+000	1231.363	1230.473	1230.072
18+100	1230.963 / 1229.963	1230.073 / 1229.073	1229.987
18+200	1229.563	1228.673	1228.646
18+300	1229.163 / 1228.163	1228.273 / 1227.273	1227.998
18+400	1228.368	1227.217	1227.227
18+500	1228.313	1227.162	1226.014
18+600	1228.257	1227.106	1224.956
18+700	1228.202	1227.050	1224.903
18+800	1228.146	1226.995	1224.765
18+900	1228.091	1226.939	1225.715
19+000	1228.035	1226.884	1226.007
19+100	1227.980	1226.828	1226.021
19+200	1227.924	1226.773	1226.028
19+300	1227.868	1226.717	1226.286
19+400	1227.813	1226.662	1226.612
19+420	1227.795	1226.650	
19+430	1227.782	1226.645	
19+500	1227.743	1226.606	1226.806
19+550	1227.681	1226.573	1226.814
19+600	1227.648	1226.539	1226.795
19+700	1227.581	1226.473	1226.589

HORIZONITAL
0 50 100 200
m

VERTICAL (PROFILE)
0 5 10 20
m

CLIENT : ASIAN DEVELOPMENT BANK	CONSTRUCTION SUPERVISION: Techno-Consult International (Pvt.)Ltd.	PROJECT: BALOCHISTAN WATER RESOURCES DEVELOPMENT PROJECT (TA)	DRAWING TITLE : RIGHT CHANNEL PLAN & PROFILE AT 18+000 TO 19+700	Designed By : SAAD-UR-REHMAN	Date : NOVEMBER 2017
		SCHEME: SIRI TOI DAM ZHOB RIVER BASIN		Drawn By : ARSALAN RAFAT	Scale : AS SHOWN
				Checked By : ZAFAR MASOOD SIDDIQUE	Drg No :
				Approved By : DR BASHIR LAKHANI	BWRDP-ZRB-STD-PP-515

No.	Revision	By	Date



CLIENT:

ADB

ASIAN DEVELOPMENT BANK

CONSULTANT:

Techno-Consult International (Pvt.) Ltd.

PROJECT:

BALOCHISTAN WATER RESOURCES DEVELOPMENT PROJECT (TA)

SCHEME:

SIRI TOI DAM
ZHOB RIVER BASIN

DRAWING TITLE:

LEFT CANAL
LINE DIAGRAM

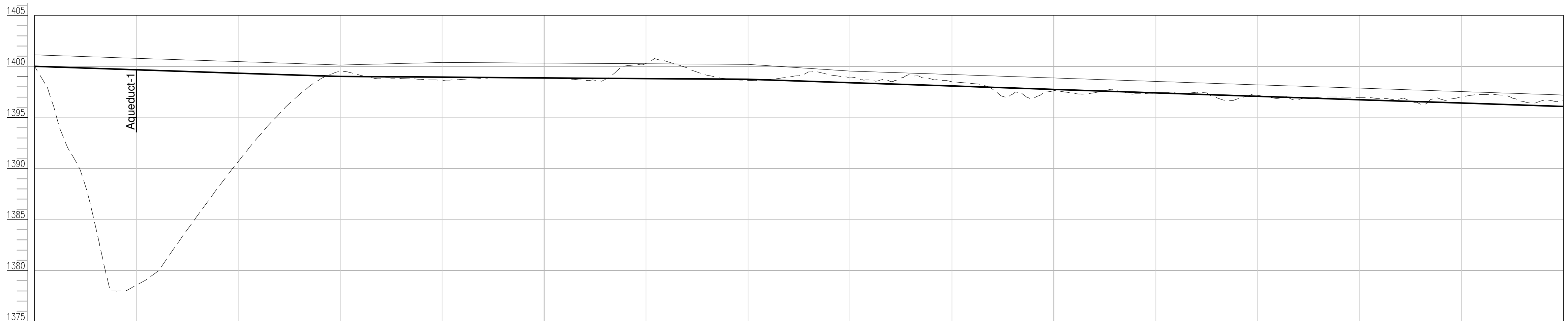
Designed By:	MEHROZ AFTAB	Date:	NOVEMBER 2017
Drawn By:	FARHAN AHMED	Scale:	AS SHOWN
Checked By:	ZAFAR MASOOD SIDDIQUE	Drg No:	BWRDP-ZRB-STD-PP-516
Approved By:	DR BASHIR LAKHANI		

No.	Revision

NOTE:
1. ALL DIMENSIONS & LEVELS ARE IN METER.

LEGEND:

- MAIN CANAL
- DL-1 DISTRIBUTARY CANAL
- BL-1 BRANCH CANAL
- ROAD
- 1400 CONTOUR
- RIVER
- STREAM
- COMMAND AREA
- SETTLEMENTS
- FALL STRUCTURE
- FLOW DIRECTION



DATUM

BED SLOPE	1:300	1:1500	1:300
VELOCITY	1.97	1.09	1.97
DESIGN FLOW (CUMECS)	2.00		
CANAL TYPE	AQUEDUCT	TRAPEZOIDAL	
BED WIDTH, B (m)	1.00		
CANAL DEPTH, D (m)	1.12	1.45	1.12

DISTANCE (m)	BTL (m)	DBL (m)	NSL (m)
000	1401.124	1400.000	1400.011
0+100	1400.791	1399.667	1378.560
00+200	1400.458	1399.333	1390.689
00+300	1400.124	1399.000	1399.460
00+400	1400.380	1398.933	1398.633
00+500	1400.313	1398.867	1398.869
00+600	1400.246	1398.800	1400.300
00+700	1400.180	1398.733	1398.617
00+800	1399.524	1398.400	1398.934
00+900	1399.191	1398.067	1398.494
01+000	1398.858	1397.733	1397.618
01+100	1398.524	1397.400	1397.382
01+200	1398.191	1397.067	1397.174
01+300	1397.858	1396.733	1396.957
01+400	1397.524	1396.400	1397.014
01+500	1397.191	1396.067	1396.644

HORIZONITAL
0 50 100 200
m

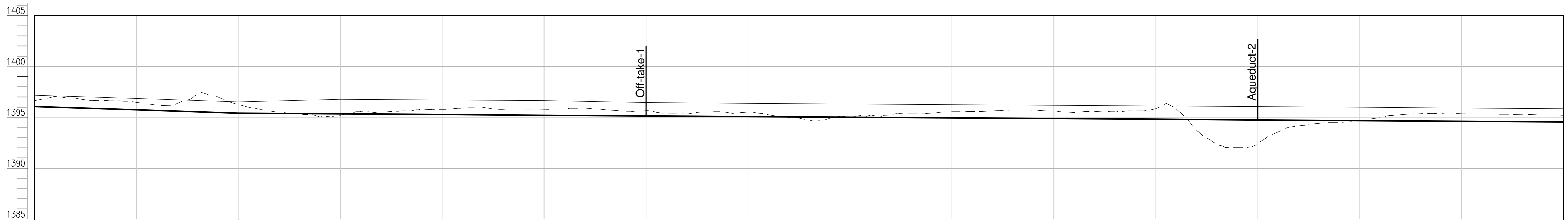
VERTICAL (PROFILE)
0 5 10 20
m

CLIENT : ADB ASIAN DEVELOPMENT BANK	CONSTRUCTION SUPERVISION: Techno-Consult International (Pvt.)Ltd.	PROJECT: BALOCHISTAN WATER RESOURCES DEVELOPMENT PROJECT (TA)	DRAWING TITLE : LEFT CANAL PLAN & PROFILE AT 0+000 TO 1+500	Designed By : MEHROZ AFTAB	Date : NOVEMBER 2017
		SCHEME: SIRI TOI DAM ZHOB RIVER BASIN		Drawn By : ARSALAN RAFAT	Scale : AS SHOWN
				Checked By : ZAFAR MASOOD SIDDIQUE	Drg No : BWRDP-ZRB-STD-PP-517
				Approved By : DR BASHIR LAKHANI	

No.	Revision	By	Date

NOTE:
1. ALL DIMENSIONS & LEVELS ARE IN METER.

LEGEND:
- MAIN CANAL
- DL-1 DISTRIBUTARY CANAL
- BL-1 BRANCH CANAL
- ROAD
- 1400 CONTOUR
- RIVER
- STREAM
- COMMAND AREA
- SETTLEMENTS
- FALL STRUCTURE
- FLOW DIRECTION



DATUM

BED SLOPE	1:300			1:1500													
VELOCITY	1.97			1.09			1.01										
DESIGN FLOW (CUMECS)	2.00						1.50										
CANAL TYPE	TRAPEZOIDAL																
BED WIDTH, B (m)	1.00																
CANAL DEPTH, D (m)	1.12			1.45			1.32										
BTL (m)	1397.191	1396.858	1396.524	1396.780	1396.713	1396.646	1396.451	1396.385	1396.318	1396.251	1396.185	1396.118	1396.051	1395.985	1395.918	1395.851	
DBL (m)	1396.067	1395.733	1395.400	1395.333	1395.267	1395.200	1395.133	1395.067	1395.000	1394.933	1394.867	1394.800	1394.733	1394.667	1394.600	1394.533	
NSL (m)	1396.644	1396.469	1396.265	1395.182	1395.787	1395.795	1395.649	1395.505	1395.146	1395.542	1395.614	1395.857	1392.436	1394.657	1395.348	1395.190	
DISTANCE (m)	01+500	01+600	01+700	01+800	01+900	02+000	02+100	02+200	02+300	02+400	02+500	02+600	02+700	02+800	02+900	03+000	

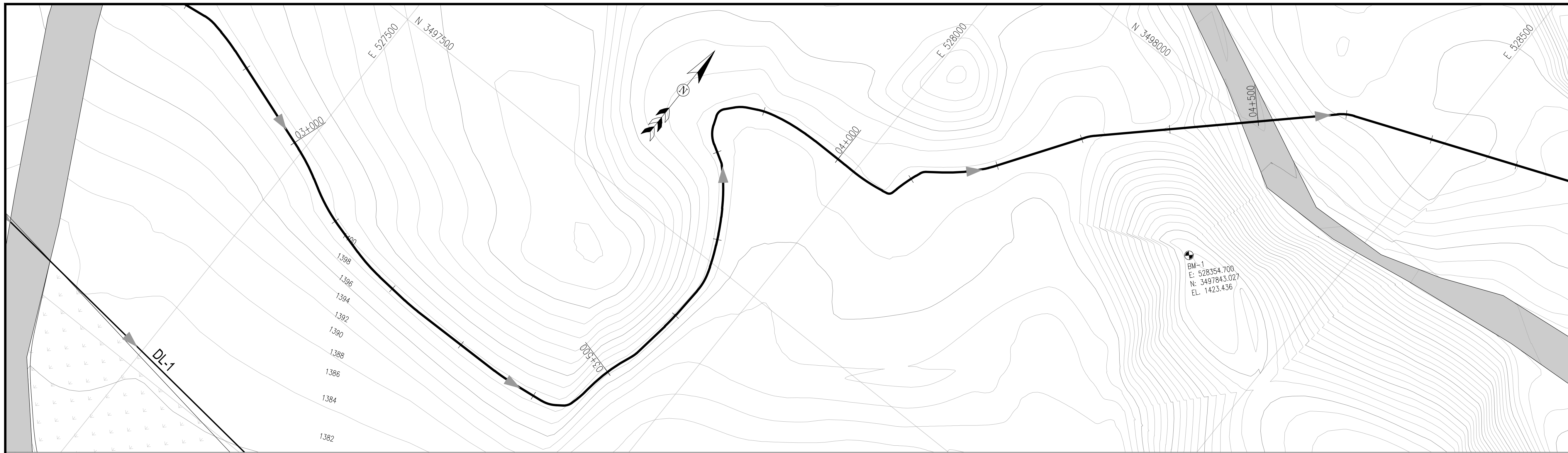
HORIZONITAL
0 50 100 200
m

VERTICAL (PROFILE)
0 5 10 20
m

CLIENT : ADB ASIAN DEVELOPMENT BANK	CONSTRUCTION SUPERVISION: Techno-Consult International (Pvt.)Ltd.	PROJECT: BALOCHISTAN WATER RESOURCES DEVELOPMENT PROJECT (TA)	DRAWING TITLE : LEFT CANAL PLAN & PROFILE AT 1+500 TO 3+000	
		SCHEME: SIRI TOI DAM ZHOB RIVER BASIN		

Designed By :	MEHROZ AFTAB	Date :	NOVEMBER 2017
Drawn By :	ARSALAN RAFAT	Scale :	AS SHOWN
Checked By :	ZAFAR MASOOD SIDDIQUE	Drg No :	
Approved By :	DR BASHIR LAKHANI		BWRDP-ZRB-STD-PP-518

No.	Revision	By	Date

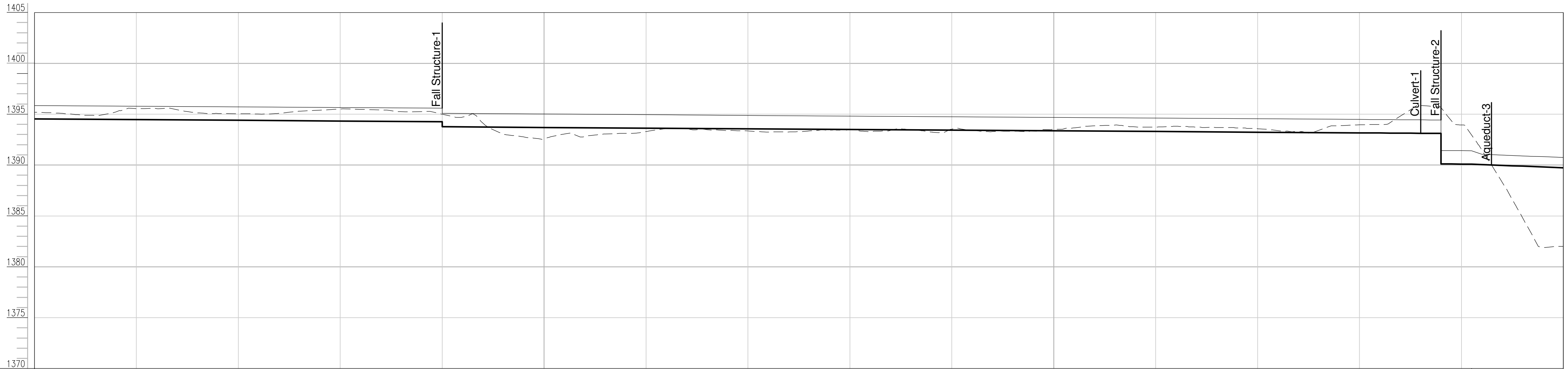


NOTE:

1. ALL DIMENSIONS & LEVELS ARE IN METER.

LEGEND:

- MAIN CANAL
- DL-1 DISTRIBUTARY CANAL
- BL-1 BRANCH CANAL
- ROAD
- 1400 CONTOUR
- RIVER
- STREAM
- COMMAND AREA
- SETTLEMENTS
- FALL STRUCTURE
- FLOW DIRECTION



DATUM

BED SLOPE	1:1500 (03+000 to 04+400)														1:250 (04+400 to 04+500)	
VELOCITY	1.01 (03+000 to 04+400)														1.95 (04+400 to 04+500)	
DESIGN FLOW (CUMECS)	1.50															
CANAL TYPE	TRAPEZOIDAL															
BED WIDTH, B (m)	1.00															
CANAL DEPTH, D (m)	1.32 (03+000 to 04+400)														1.01 (04+400 to 04+500)	
BTL (m)	1395.851	1395.785	1395.718	1395.651	1395.584 / 1395.084	1395.018	1394.951	1394.884	1394.818	1394.751	1394.684	1394.618	1394.551	1394.484	1394.431 / 1391.431 / 1391.418	1390.743
DBL (m)	1394.533	1394.467	1394.400	1394.333	1394.267 / 1393.767	1393.700	1393.633	1393.567	1393.500	1393.433	1393.367	1393.300	1393.233	1393.167	1393.113 / 1390.113 / 1390.100	1389.733
NSL (m)	1395.190	1395.556	1395.049	1395.506	1395.005	1392.594	1393.296	1393.351	1393.473	1393.536	1393.513	1393.735	1393.575	1393.958	1393.951	1382.007
DISTANCE (m)	03+000	03+100	03+200	03+300	03+400	03+500	03+600	03+700	03+800	03+900	04+000	04+100	04+200	04+300	04+400	04+500

HORIZONITAL

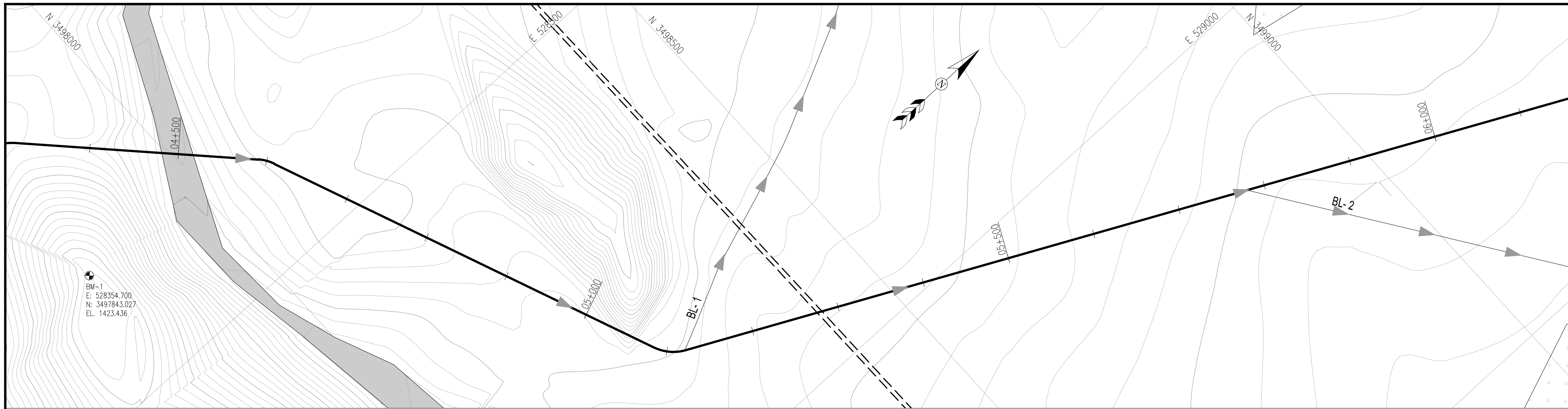
0 50 100 200 m

VERTICAL (PROFILE)

0 5 10 20 m

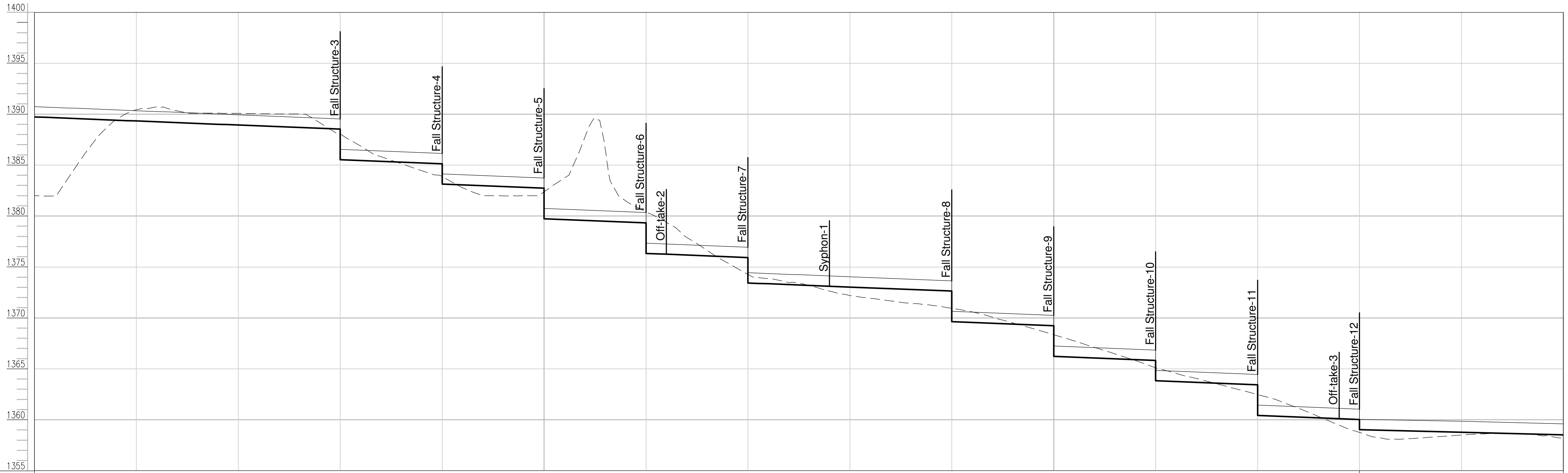
CLIENT :	CONSTRUCTION SUPERVISION:	PROJECT:	DRAWING TITLE :				
ADB ASIAN DEVELOPMENT BANK	Techno-Consult International (Pvt.)Ltd.	BALOCHISTAN WATER RESOURCES DEVELOPMENT PROJECT (TA)	LEFT CANAL PLAN & PROFILE AT 3+000 TO 4+500	Designed By : MEHROZ AFTAB	Date : NOVEMBER 2017		
		SCHEME: SIRI TOI DAM ZHOB RIVER BASIN		Drawn By : ARSALAN RAFAT	Scale : AS SHOWN		
				Checked By : ZAFAR MASOOD SIDDIQUE	Drg No :		
				Approved By : DR BASHIR LAKHANI	BWRDP-ZRB-STD-PP-519		

No.	Revision	By	Date



NOTE:
1. ALL DIMENSIONS & LEVELS ARE IN METER.

LEGEND:
- MAIN CANAL
- DL-1 DISTRIBUTARY CANAL
- BL-1 BRANCH CANAL
- ROAD
- CONTOUR
- RIVER
- STREAM
- COMMAND AREA
- SETTLEMENTS
- FALL STRUCTURE
- FLOW DIRECTION



DATUM

	04+500 to 05+800	05+800 to 06+000
BED SLOPE	1:250	1:400
VELOCITY	1.95	1.64
DESIGN FLOW (CUMECS)	1.50	1.50
CANAL TYPE	TRAPEZOIDAL	TRAPEZOIDAL
BED WIDTH, B (m)	1.00	1.00
CANAL DEPTH, D (m)	1.01	1.08

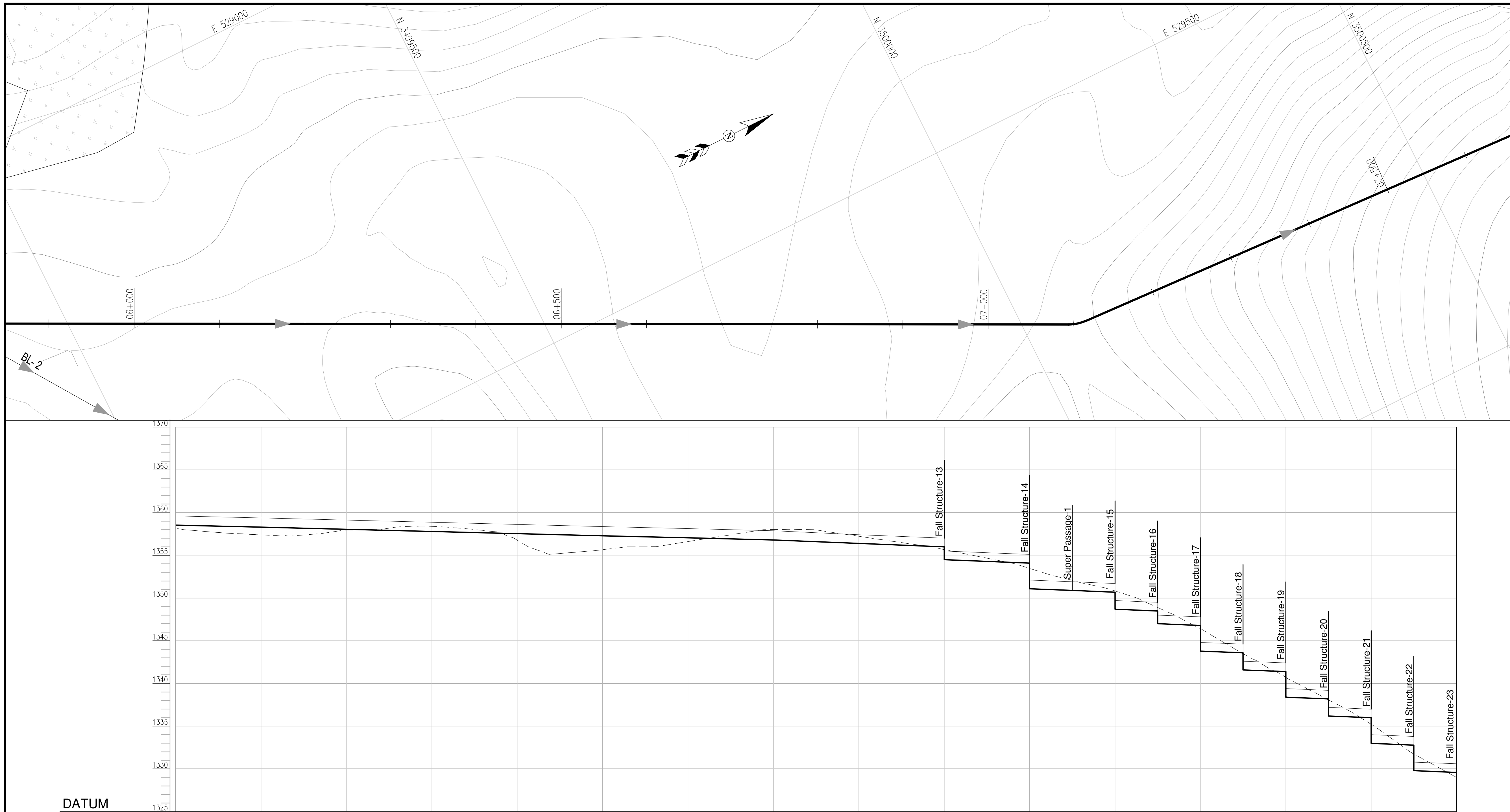
DISTANCE (m)	BTL (m)	DBL (m)	NSL (m)
04+500	1390.743	1389.733	1382.007
04+600	1390.343	1389.333	1390.435
04+700	1389.943	1388.933	1390.081
04+800	1389.543 / 1386.543	1388.533 / 1385.533	1388.020
04+900	1386.143 / 1384.143	1385.133 / 1383.133	1383.878
05+000	1383.743 / 1380.743	1382.733 / 1379.733	1382.384
05+100	1380.343 / 1377.343	1379.333 / 1376.333	1380.414
05+200	1376.943 / 1374.443	1375.933 / 1373.433	1374.269
05+300	1374.043	1373.033	1372.201
05+400	1373.643 / 1370.643	1372.633 / 1369.633	1370.946
05+500	1370.243 / 1367.243	1369.233 / 1366.233	1368.347
05+600	1366.843 / 1364.843	1365.833 / 1363.833	1365.096
05+700	1364.443 / 1361.443	1363.433 / 1360.433	1362.482
05+800	1361.043 / 1360.043	1360.033 / 1359.033	1358.771
05+900	1359.862	1358.783	1358.505
06+000	1359.612	1358.533	1358.157

HORIZONITAL
0 50 100 200
m

VERTICAL (PROFILE)
0 5 10 20
m

CLIENT :	ADB ASIAN DEVELOPMENT BANK
CONSTRUCTION SUPERVISION:	Techno-Consult International (Pvt.)Ltd.
PROJECT:	BALOCHISTAN WATER RESOURCES DEVELOPMENT PROJECT (TA)
SCHEME:	SIRI TOI DAM ZHOB RIVER BASIN
DRAWING TITLE :	LEFT CANAL PLAN & PROFILE AT 4+500 TO 6+000
Designed By :	MEHROZ AFTAB
Drawn By :	ARSALAN RAFAT
Checked By :	ZAFAR MASOOD SIDDIQUE
Approved By :	DR BASHIR LAKHANI
Date :	NOVEMBER 2017
Scale :	AS SHOWN
Drg No :	BWRDP-ZRB-STD-PP-520

No.	Revision	By	Date



NOTE:
1. ALL DIMENSIONS & LEVELS ARE IN METER.

LEGEND:
- MAIN CANAL
- —DL-1— DISTRIBUTARY CANAL
- —BL-1— BRANCH CANAL
- ROAD
- 1400 CONTOUR
- RIVER
- STREAM
- COMMAND AREA
- SETTLEMENTS
- FALL STRUCTURE
- FLOW DIRECTION

DATUM

	06+000 to 06+700	06+700 to 07+500
BED SLOPE	1:400	1:250
VELOCITY	1.64	1.95
DESIGN FLOW (CUMECS)	1.50	1.50
CANAL TYPE	TRAPEZOIDAL	TRAPEZOIDAL
BED WIDTH, B (m)	1.00	1.00
CANAL DEPTH, D (m)	1.08	1.01

DISTANCE (m)	NSL (m)	DBL (m)	BTL (m)
06+000	1358.157	1358.533	1359.612
06+100	1357.384	1358.283	1359.362
06+200	1357.946	1358.033	1359.112
06+300	1358.387	1357.783	1358.862
06+400	1356.762	1357.533	1358.612
06+500	1355.653	1357.283	1358.362
06+600	1356.603	1357.033	1358.112
06+700	1358.011	1356.783	1357.862
06+800	1357.218	1356.383	1357.393
06+900	1355.663	1355.983 / 1354.483	1356.993 / 1355.493
07+000	1353.463	1354.083 / 1351.083	1355.093 / 1352.093
	1352.073	1350.883	1351.893
07+100	1350.823	1350.683 / 1348.683	1351.693 / 1349.693
	1348.880	1348.483 / 1346.983	1349.493 / 1347.993
07+200	1346.416	1346.783 / 1343.783	1347.793 / 1344.793
	1343.485	1343.583 / 1341.583	1344.593 / 1342.593
07+300	1340.716	1341.383 / 1338.383	1342.393 / 1339.393
	1338.058	1338.183 / 1336.183	1339.193 / 1337.193
07+400	1335.233	1338.983	1338.993
	1331.727	1332.783 / 1329.783	1333.793 / 1330.793
07+500	1329.013	1329.583	1330.593

HORIZONITAL
0 50 100 200
m

VERTICAL (PROFILE)
0 5 10 20
m

CLIENT :	CONSTRUCTION SUPERVISION:	PROJECT:	DRAWING TITLE :		
ASIAN DEVELOPMENT BANK	Techno-Consult International (Pvt.)Ltd.	BALOCHISTAN WATER RESOURCES DEVELOPMENT PROJECT (TA)	LEFT CANAL PLAN & PROFILE AT 6+000 TO 7+500	Designed By : MEHROZ AFTAB	Date : NOVEMBER 2017
		SCHEME: SIRI TOI DAM ZHOB RIVER BASIN		Drawn By : ARSALAN RAFAT	Scale : AS SHOWN
				Checked By : ZAFAR MASOOD SIDDIQUE	Drg No :
				Approved By : DR BASHIR LAKHANI	BWRDP-ZRB-STD-PP-521

No.	Revision	By	Date

NOTE:

1. ALL DIMENSIONS & LEVELS ARE IN METER.

LEGEND:

- MAIN CANAL
- —DL-1— DISTRIBUTARY CANAL
- —BL-1— BRANCH CANAL
- ROAD
- 1400 CONTOUR
- RIVER
- STREAM
- COMMAND AREA
- SETTLEMENTS
- FALL STRUCTURE
- FLOW DIRECTION

DATUM

	07+500 to 07+900	07+900 to 08+800	08+800 to 09+000
BED SLOPE	1:250	1:75	1:2500
VELOCITY	1.95	3.08	0.83
DESIGN FLOW (CUMECS)	1.50	1.50	1.50
CANAL TYPE	TRAPEZOIDAL	SYPHON	TRAPEZOIDAL
BED WIDTH, B (m)	1.00	0.75	1.00
CANAL DEPTH, D (m)	1.01	0.92	1.43

DISTANCE (m)	BTL (m)	DBL (m)	NSL (m)
07+500	1328.593	1327.583	1329.013
	1328.393 / 1326.393	1327.383 / 1325.383	1326.621
07+600	1326.193 / 1325.693	1325.183 / 1324.683	1324.730
	1325.493 / 1323.493	1324.483 / 1322.483	1323.487
07+700	1323.293 / 1321.293	1322.283 / 1320.283	1320.597
07+800	1320.893	1319.883	1318.686
07+900	1320.493	1319.483	1319.330
08+000	1319.068	1318.150	1318.980
08+100	1317.734	1316.817	1316.410
08+200	1316.401	1315.483	1315.163
08+300	1315.068	1314.150	1314.506
08+400	1313.734	1312.817	1312.937
08+500	1312.401	1311.483	1311.938
08+600	1311.068	1310.150	1311.909
08+700	1309.734	1308.817	1310.539
08+800	1310.993	1309.561	1309.561
08+900	1310.953	1309.521	1311.223
09+000	1310.913	1309.481	1300.364

HORIZONTAL

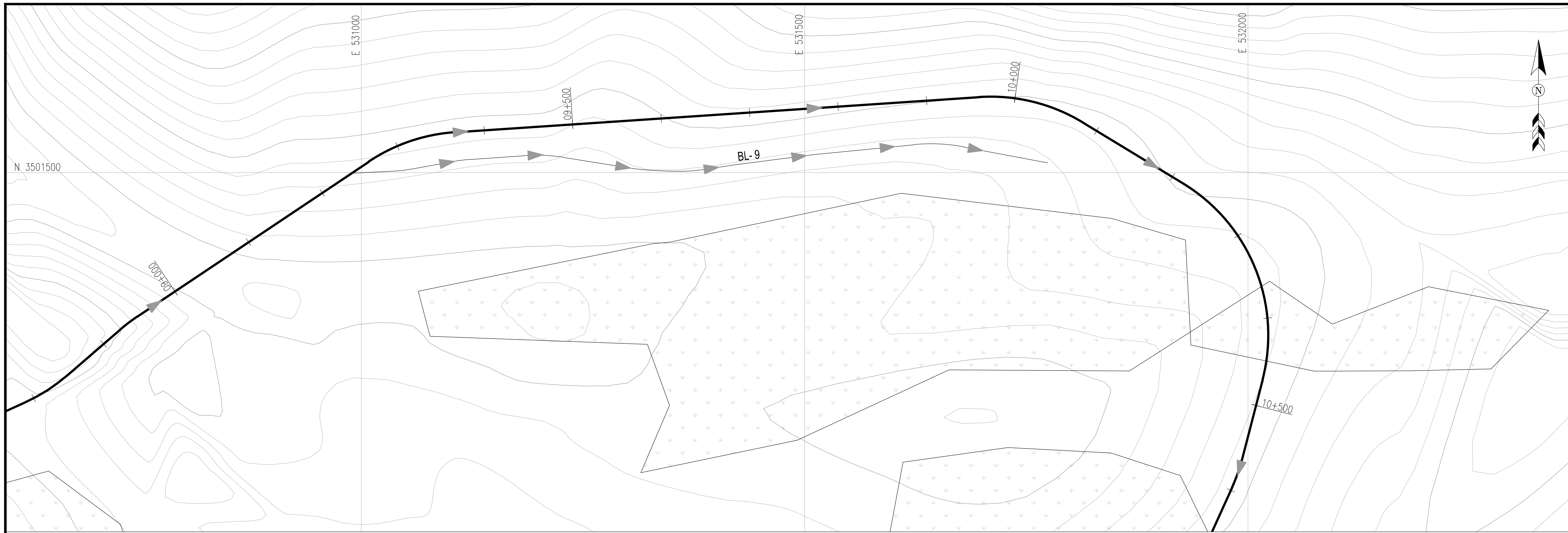
0 50 100 200 m

VERTICAL (PROFILE)

0 5 10 20 m

CLIENT :	CONSTRUCTION SUPERVISION:	PROJECT:	DRAWING TITLE :		
ADB ASIAN DEVELOPMENT BANK	Techno-Consult International (Pvt.)Ltd.	BALOCHISTAN WATER RESOURCES DEVELOPMENT PROJECT (TA)	LEFT CANAL PLAN & PROFILE AT 7+500 TO 9+000	Designed By : MEHROZ AFTAB	Date : NOVEMBER 2017
		SCHEME: SIRI TOI DAM ZHOB RIVER BASIN		Drawn By : ARSALAN RAFAT	Scale : AS SHOWN
				Checked By : ZAFAR MASOOD SIDDIQUE	Drg No :
				Approved By : DR BASHIR LAKHANI	BWRDP-ZRB-STD-PP-522

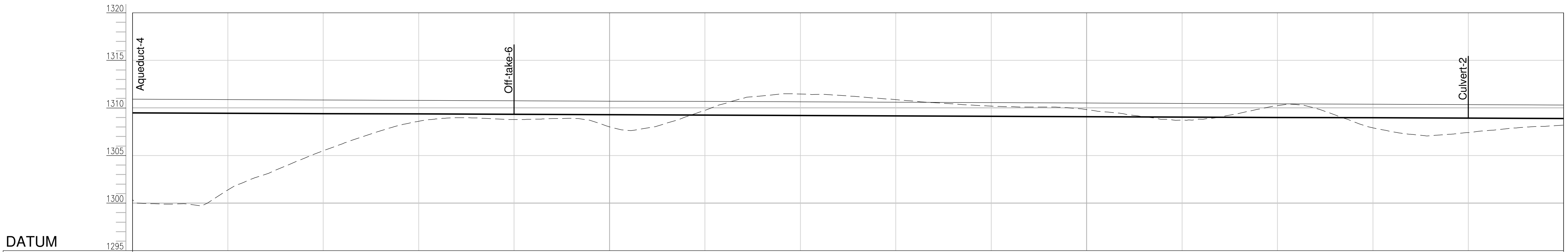
No.	Revision	By	Date



NOTE:
1. ALL DIMENSIONS & LEVELS ARE IN METER.

N

LEGEND:
- MAIN CANAL
- DL-1 DISTRIBUTARY CANAL
- BL-1 BRANCH CANAL
- ROAD
- 1400 CONTOUR
- RIVER
- STREAM
- COMMAND AREA
- SETTLEMENTS
- FALL STRUCTURE
- FLOW DIRECTION



DATUM

BED SLOPE	1:2500
VELOCITY	0.83
DESIGN FLOW (CUMECS)	1.50
CANAL TYPE	TRAPEZOIDAL
BED WIDTH, B (m)	1.00
CANAL DEPTH, D (m)	1.43

DISTANCE (m)	09+000	09+100	09+200	09+300	09+400	09+500	09+600	09+700	09+800	09+900	10+000	10+100	10+200	10+300	10+400	10+500
BTL (m)	1310.913	1310.873	1310.833	1310.793	1310.753	1310.713	1310.673	1310.633	1310.593	1310.553	1310.513	1310.473	1310.433	1310.393	1310.353	1310.313
DBL (m)	1309.481	1309.441	1309.401	1309.361	1309.321	1309.281	1309.241	1309.201	1309.161	1309.121	1309.081	1309.041	1309.001	1308.961	1308.921	1308.881
NSL (m)	1300.364	1301.374	1305.502	1308.596	1308.786	1308.008	1309.742	1311.462	1310.865	1310.191	1309.830	1308.713	1310.239	1307.909	1307.406	1308.203

HORIZONITAL
0 50 100 200
m

VERTICAL (PROFILE)
0 5 10 20
m

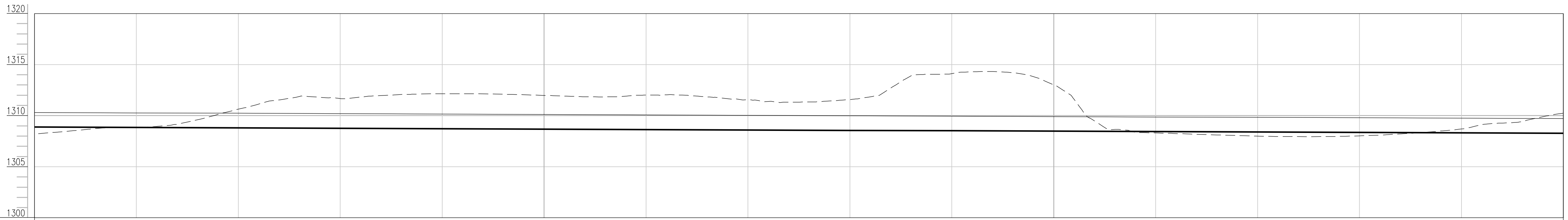
CLIENT : ADB ASIAN DEVELOPMENT BANK	CONSTRUCTION SUPERVISION: Techno-Consult International (Pvt.)Ltd.	PROJECT: BALOCHISTAN WATER RESOURCES DEVELOPMENT PROJECT (TA) SCHEME: SIRI TOI DAM ZHOB RIVER BASIN	DRAWING TITLE : LEFT CANAL PLAN & PROFILE AT 9+000 TO 10+500	Designed By : MEHROZ AFTAB Drawn By : ARSALAN RAFAT Checked By : ZAFAR MASOOD SIDDIQUE Approved By : DR BASHIR LAKHANI	Date : NOVEMBER 2017 Scale : AS SHOWN Drg No : BWRDP-ZRB-STD-PP-523

No.	Revision	By	Date

NOTE:
1. ALL DIMENSIONS & LEVELS ARE IN METER.

LEGEND:

(thick line)	MAIN CANAL
—DL-1—	DISTRIBUTARY CANAL
—BL-1—	BRANCH CANAL
========	ROAD
1400	CONTOUR
	RIVER
	STREAM
	COMMAND AREA
	SETTLEMENTS
	FALL STRUCTURE
	FLOW DIRECTION



DATUM	
BED SLOPE	1:2500
VELOCITY	0.83
DESIGN FLOW (CUMECS)	1.50
CANAL TYPE	TRAPEZOIDAL
BED WIDTH, B (m)	1.00
CANAL DEPTH, D (m)	1.43

DISTANCE (m)	BTL (m)	DBL (m)	NSL (m)
10+500	1310.313	1308.881	1308.203
10+600	1310.273	1308.841	1308.857
10+700	1310.233	1308.801	1310.634
10+800	1310.193	1308.761	1311.673
10+900	1310.153	1308.721	1312.154
11+000 11+000	1310.113	1308.681	1311.987
11+100	1310.073	1308.641	1312.016
11+200	1310.033	1308.601	1311.576
11+300	1309.993	1308.561	1311.582
11+400	1309.953	1308.521	1314.113
11+500	1309.913	1308.481	1313.027
11+600	1309.873	1308.441	1308.305
11+700	1309.833	1308.401	1307.996
11+800	1309.793	1308.361	1308.022
11+900	1309.753	1308.321	1308.696
12+000	1309.713	1308.281	1310.248

HORIZONITAL
0 50 100 200
m

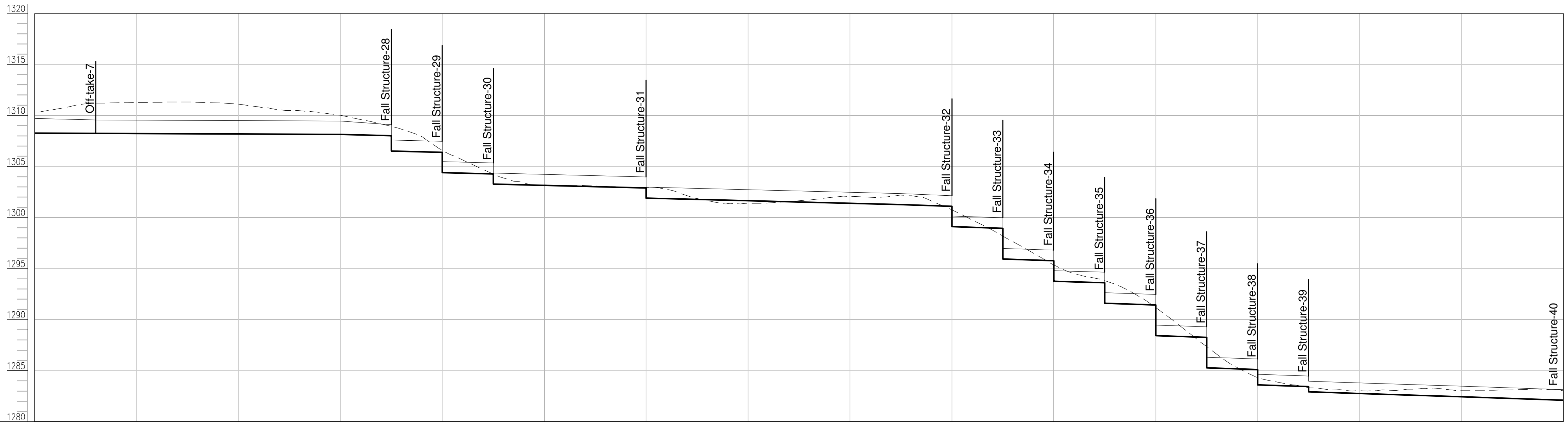
VERTICAL (PROFILE)
0 5 10 20
m

CLIENT :	ADB ASIAN DEVELOPMENT BANK
CONSTRUCTION SUPERVISION:	Techno-Consult International (Pvt.)Ltd.
PROJECT:	BALOCHISTAN WATER RESOURCES DEVELOPMENT PROJECT (TA)
SCHEME:	SIRI TOI DAM ZHOB RIVER BASIN
DRAWING TITLE :	LEFT CANAL PLAN & PROFILE AT 10+500 TO 12+000
Designed By :	MEHROZ AFTAB
Drawn By :	ARSALAN RAFAT
Checked By :	ZAFAR MASOOD SIDDIQUE
Approved By :	DR BASHIR LAKHANI
Date :	NOVEMBER 2017
Scale :	AS SHOWN
Drg No :	BWRDP-ZRB-STD-PP-524

No.	Revision	By	Date

NOTE:
1. ALL DIMENSIONS & LEVELS ARE IN METER.

LEGEND:
- MAIN CANAL
- DL–1 DISTRIBUTARY CANAL
- BL–1 BRANCH CANAL
- ROAD
- 1400 CONTOUR
- RIVER
- STREAM
- COMMAND AREA
- SETTLEMENTS
- FALL STRUCTURE
- FLOW DIRECTION



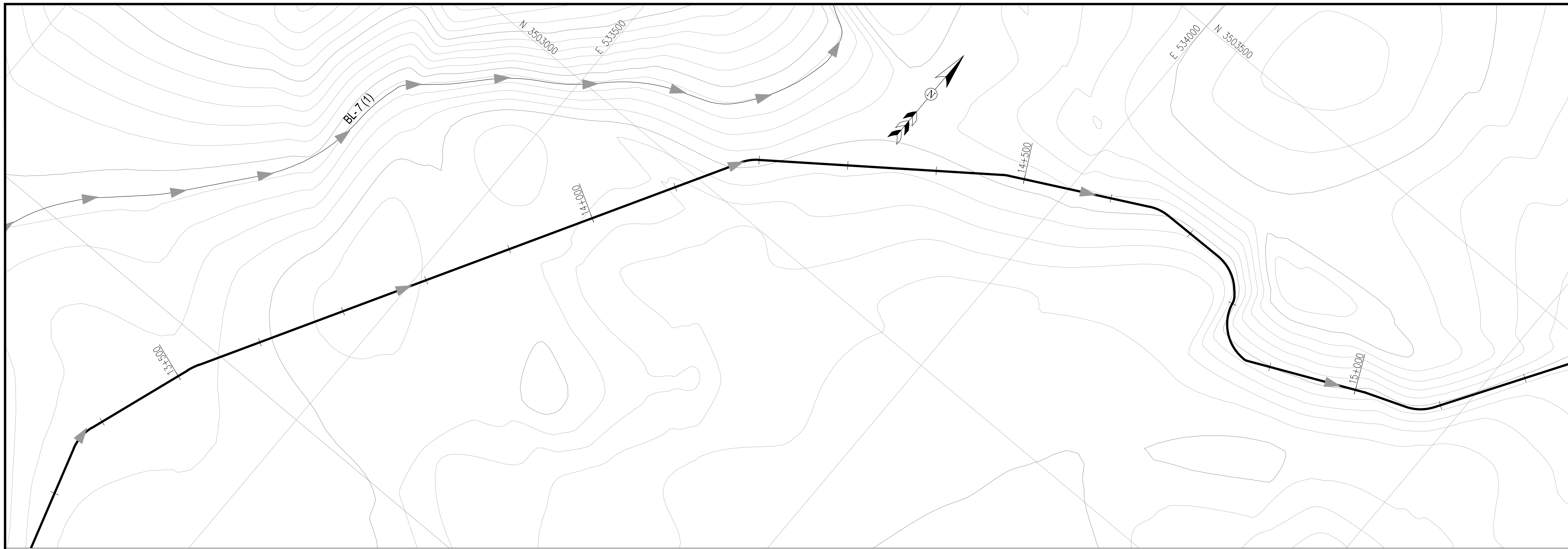
DATUM	12+000 to 12+300	12+300 to 12+850	12+850 to 13+500
BED SLOPE	1:2200	1:400	1:300
VELOCITY	0.83	1.57	1.74
DESIGN FLOW (CUMECS)	1.20	1.20	1.20
CANAL TYPE	TRAPEZOIDAL	TRAPEZOIDAL	TRAPEZOIDAL
BED WIDTH, B (m)	1.00	0.75	0.75
CANAL DEPTH, D (m)	1.30	1.08	1.04

DISTANCE (m)	NSL (m)	DBL (m)	BTL (m)
12+000	1310.248	1308.281	1309.713
		1308.254	1309.559
12+100	1311.273	1308.236	1309.541
	1311.321	1308.213	1309.518
12+200	1311.107	1308.190	1309.495
	1310.484	1308.168	1309.473
12+300	1310.009	1308.145	1309.450
	1308.928	1308.020 1306.520	1309.098 1307.598
12+400	1306.587	1306.395 1304.395	1307.473 1305.473
	1304.261	1304.270 1303.270	1305.348 1304.348
12+500	1303.190	1303.145	1304.223
	1303.086	1303.020	1304.098
12+600	1302.945	1302.895 1301.895	1303.973 1302.973
	1301.856	1301.770	1302.848
12+700	1301.393	1301.645	1302.723
	1301.639	1301.520	1302.598
12+800	1302.079	1301.395	1302.473
	1302.189	1301.270	1302.348
12+900	1300.750	1301.103 1299.103	1302.139 1300.139
	1298.185	1298.937 1295.937	1299.973 1296.973
13+000	1295.358	1295.770 1293.770	1296.806 1294.806
	1293.805	1293.603 1291.603	1294.639 1292.639
13+100	1291.181	1291.437 1288.437	1292.473 1289.473
	1287.351	1288.270 1285.270	1289.306 1286.306
13+200	1284.323	1285.103 1283.603	1286.139 1284.639
	1283.347	1283.437 1282.937	1284.473 1283.973
13+300	1283.037	1282.770	1283.806
13+400	1283.085	1282.437	1283.473
13+500	1283.039	1282.103 1280.603	1283.139 1281.639

HORIZONITAL
0 50 100 200 m

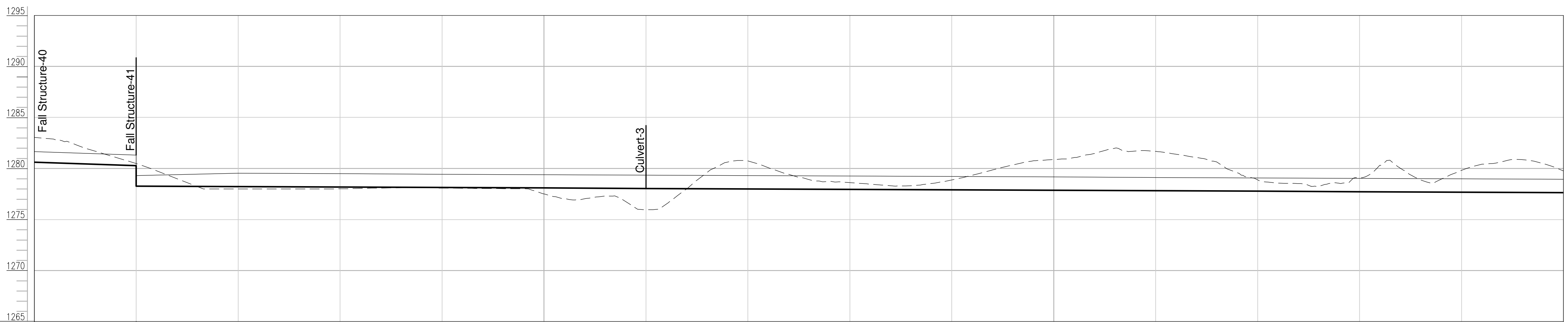
VERTICAL (PROFILE)
0 5 10 20 m

CLIENT :	CONSTRUCTION SUPERVISION:	PROJECT:	DRAWING TITLE :			No.	Revision	By	Date
ADB ASIAN DEVELOPMENT BANK	Techno-Consult International (Pvt.)Ltd.	BALOCHISTAN WATER RESOURCES DEVELOPMENT PROJECT (TA) SCHEME: SIRI TOI DAM ZHOB RIVER BASIN	LEFT CANAL PLAN & PROFILE AT 12+000 TO 13+500	Designed By : MEHROZ AFTAB Drawn By : ARSALAN RAFAT Checked By : ZAFAR MASOOD SIDDIQUE Approved By : DR BASHIR LAKHANI	Date : NOVEMBER 2017 Scale : AS SHOWN Drg No : BWRDP-ZRB-STD-PP-525				



NOTE:
1. ALL DIMENSIONS & LEVELS ARE IN METER.

LEGEND:
- MAIN CANAL
- DL-1 DISTRIBUTARY CANAL
- BL-1 BRANCH CANAL
- ROAD
- 1400 CONTOUR
- RIVER
- STREAM
- COMMAND AREA
- SETTLEMENTS
- FALL STRUCTURE
- FLOW DIRECTION



DATUM

BED SLOPE	1:300	1:2200
VELOCITY	1.74	0.83
DESIGN FLOW (CUMECS)	1.20	
CANAL TYPE	TRAPEZOIDAL	
BED WIDTH, B (m)	0.75	1.00
CANAL DEPTH, D (m)	1.04	1.30

BTL (m)	1283.139 1281.639	1281.306 1279.306	1279.529	1279.484	1279.438	1279.393	1279.348	1279.302	1279.257	1279.211	1279.166	1279.120	1279.075	1279.029	1278.984	1278.939
DBL (m)	1282.103 1280.603	1280.270 1278.270	1278.225	1278.179	1278.134	1278.088	1278.043	1277.997	1277.952	1277.906	1277.861	1277.815	1277.770	1277.725	1277.679	1277.634
NSL (m)	1283.039	1280.483	1278.000	1278.009	1278.081	1277.512	1275.952	1280.732	1278.617	1278.875	1280.864	1281.671	1278.882	1279.074	1279.810	1279.756
DISTANCE (m)	13+500	13+600	13+700	13+800	13+900	14+000	14+100	14+200	14+300	14+400	14+500	14+600	14+700	14+800	14+900	15+000

HORIZONTAL
0 50 100 200
m

VERTICAL (PROFILE)
0 5 10 20
m

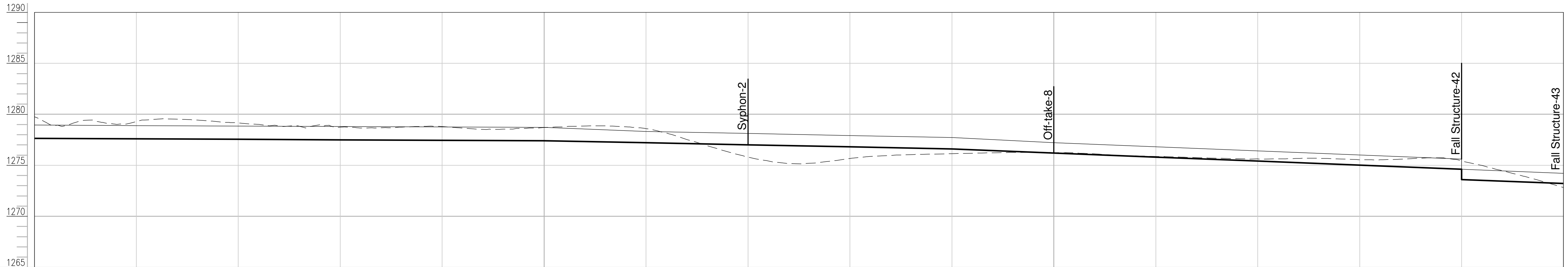
CLIENT : ADB ASIAN DEVELOPMENT BANK	CONSTRUCTION SUPERVISION: Techno-Consult International (Pvt.)Ltd.	PROJECT: BALOCHISTAN WATER RESOURCES DEVELOPMENT PROJECT (TA) SCHEME: SIRI TOI DAM ZHOB RIVER BASIN	DRAWING TITLE : LEFT CANAL PLAN & PROFILE AT 13+500 TO 15+000	

Designed By :	MEHROZ AFTAB	Date :	NOVEMBER 2017
Drawn By :	ARSALAN RAFAT	Scale :	AS SHOWN
Checked By :	ZAFAR MASOOD SIDDIQUE	Drg No :	
Approved By :	DR BASHIR LAKHANI		BWRDP-ZRB-STD-PP-526

No.	Revision	By	Date

NOTE:
1. ALL DIMENSIONS & LEVELS ARE IN METER.

LEGEND:
- MAIN CANAL
- DL–1 DISTRIBUTARY CANAL
- BL–1 BRANCH CANAL
- ROAD
- 1400 CONTOUR
- RIVER
- STREAM
- COMMAND AREA
- SETTLEMENTS
- FALL STRUCTURE
- FLOW DIRECTION



DATUM

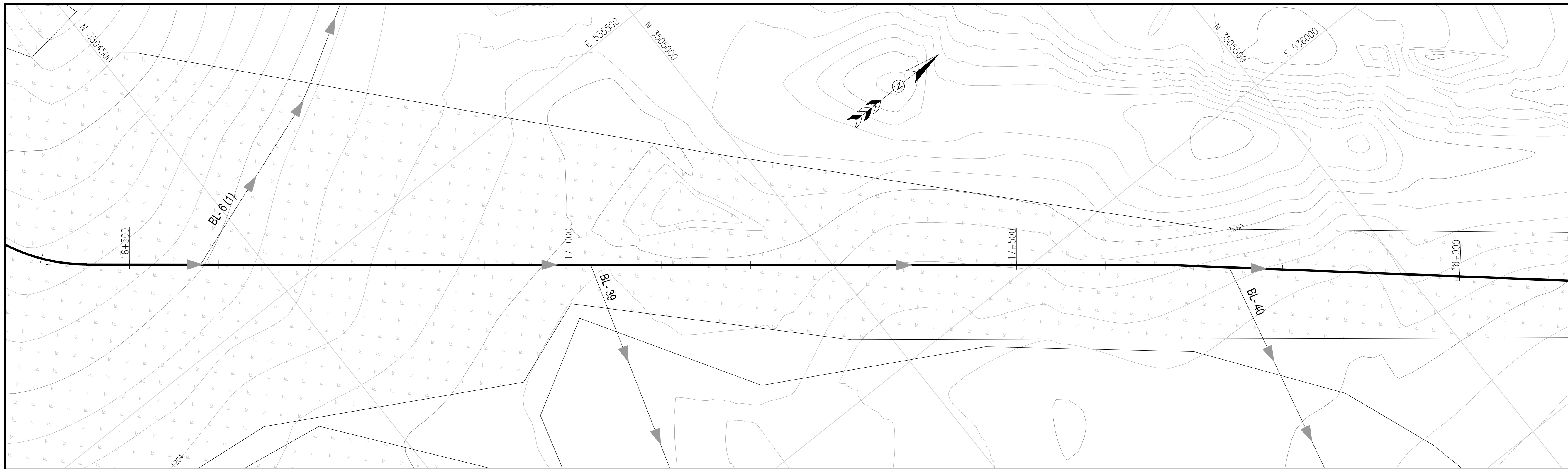
	15+000 to 15+500	15+500 to 15+900	15+900 to 16+500
BED SLOPE	1:2200	1:500	1:250
VELOCITY	0.83	1.44	1.86
DESIGN FLOW (CUMECS)	1.20		
CANAL TYPE	TRAPEZOIDAL		
BED WIDTH, B (m)	1.00		0.75
CANAL DEPTH, D (m)	1.30	1.11	1.01

DISTANCE (m)	BTL (m)	DBL (m)	NSL (m)
15+000	1278.939	1277.634	1279.756
15+100	1278.893	1277.588	1279.288
15+200	1278.847	1277.543	1279.161
15+300	1278.802	1277.497	1278.736
15+400	1278.757	1277.452	1278.798
15+500	1278.711	1277.406	1278.701
15+600	1278.318	1277.206	1278.596
15+700	1278.118	1277.006	1275.808
15+800	1277.918	1276.806	1275.659
15+900	1277.718	1276.606	1276.142
16+000	1277.217	1276.206	1276.246
16+100	1276.817	1275.806	1275.876
16+200	1276.417	1275.406	1275.620
16+300	1276.017	1275.006	1275.550
16+400	1275.617 / 1274.617	1274.606 / 1273.606	1275.432
16+500	1274.217 / 1271.717	1273.206 / 1270.706	1272.819

HORIZONITAL
0 50 100 200
m

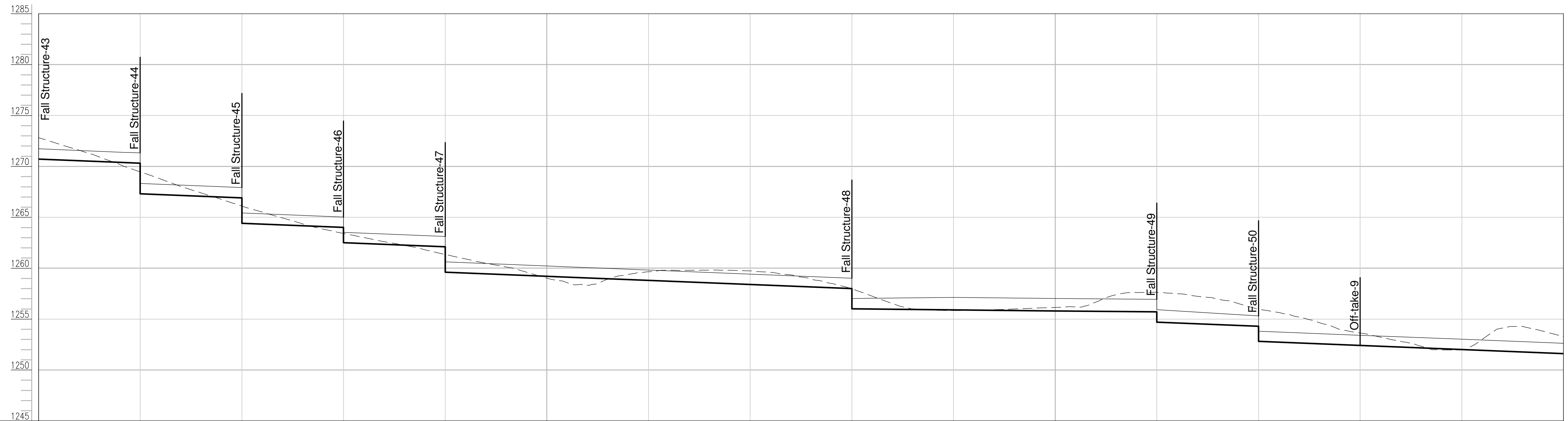
VERTICAL (PROFILE)
0 5 10 20
m

CLIENT :	CONSTRUCTION SUPERVISION:	PROJECT:	DRAWING TITLE :				
ADB ASIAN DEVELOPMENT BANK	Techno-Consult International (Pvt.)Ltd.	BALOCHISTAN WATER RESOURCES DEVELOPMENT PROJECT (TA)	LEFT CANAL PLAN & PROFILE AT 15+000 TO 16+500	Designed By : MEHROZ AFTAB	Date : NOVEMBER 2017	No.	Revision
		SCHEME: SIRI TOI DAM ZHOB RIVER BASIN		Drawn By : ARSALAN RAFAT	Scale : AS SHOWN	By	Date
				Checked By : ZAFAR MASOOD SIDDIQUE	Drg No :		
				Approved By : DR BASHIR LAKHANI	BWRDP-ZRB-STD-PP-527		



NOTE:
1. ALL DIMENSIONS & LEVELS ARE IN METER.

LEGEND:
- MAIN CANAL
- DL–1 DISTRIBUTARY CANAL
- BL–1 BRANCH CANAL
- ROAD
- CONTOUR
- RIVER
- STREAM
- COMMAND AREA
- SETTLEMENTS
- FALL STRUCTURE
- FLOW DIRECTION



DATUM

Parameter	16+500 – 17+300	17+300 – 17+600	17+600 – 18+000
BED SLOPE	1:250	1:1000	1:250
VELOCITY	1.86	1.11	1.86
DESIGN FLOW (CUMECS)	1.20	1.20	1.20
CANAL TYPE	TRAPEZOIDAL	TRAPEZOIDAL	TRAPEZOIDAL
BED WIDTH, B (m)	0.75	0.75	0.75
CANAL DEPTH, D (m)	1.01	1.23	1.01

DISTANCE (m)	NSL (m)	DBL (m)	BTL (m)
16+500	1272.819	1273.206 / 1270.706	1274.217 / 1271.717
		1270.386	1271.397
16+600	1269.467	1270.306 / 1267.306	1271.317 / 1268.317
16+700	1266.102	1266.906 / 1264.406	1267.917 / 1265.417
16+800	1263.411	1264.006 / 1262.506	1265.017 / 1263.517
16+900	1261.340	1262.106 / 1259.606	1263.117 / 1260.617
17+000	1259.024	1259.206	1260.217
		1259.126	1260.137
17+100	1259.654	1258.806	1259.817
17+200	1259.732	1258.406	1259.417
17+300	1257.977	1258.006 / 1256.006	1259.017 / 1257.017
17+400	1255.846	1255.906	1257.135
17+500	1256.148	1255.806	1257.036
17+600	1257.627	1255.706 / 1254.706	1256.936 / 1255.936
17+700	1255.976	1254.306 / 1252.806	1255.317 / 1253.817
17+800	1253.633	1252.406	1253.417
17+900	1251.988	1252.006	1253.017
18+000	1253.272	1251.606	1252.617

HORIZONITAL

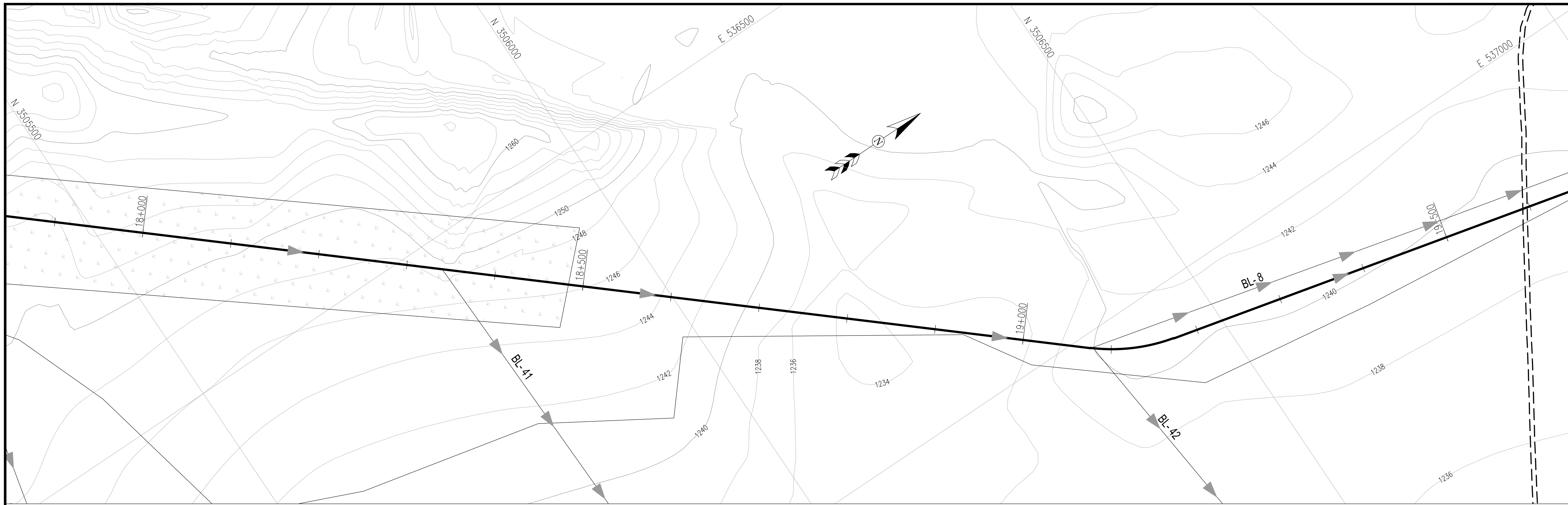
0 50 100 200 m

VERTICAL (PROFILE)

0 5 10 20 m

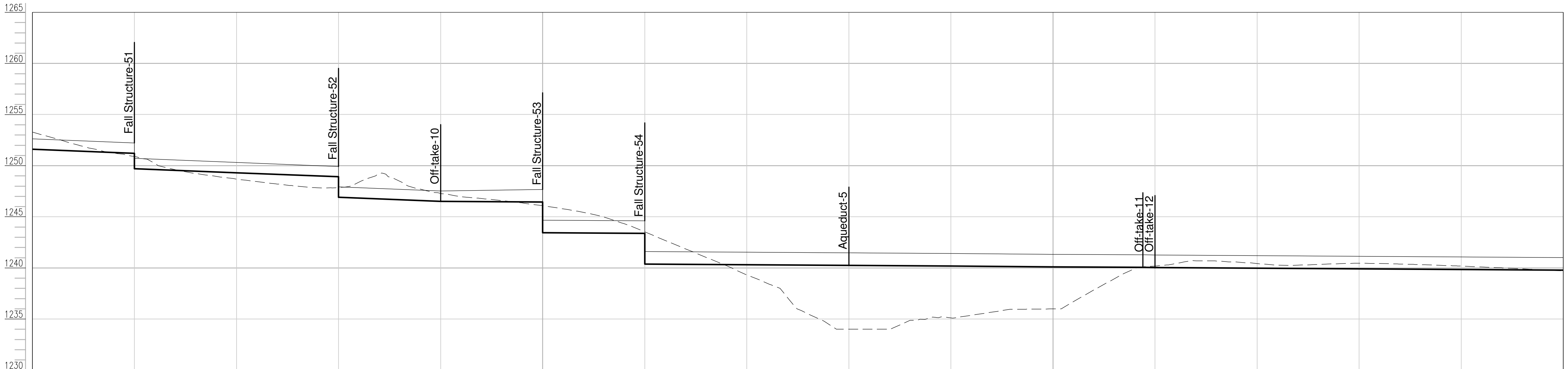
CLIENT :	CONSTRUCTION SUPERVISION:	PROJECT:	DRAWING TITLE :		
ADB ASIAN DEVELOPMENT BANK	Techno-Consult International (Pvt.)Ltd.	BALOCHISTAN WATER RESOURCES DEVELOPMENT PROJECT (TA)	LEFT CANAL PLAN & PROFILE AT 16+500 TO 18+000	Designed By : MEHROZ AFTAB	Date : NOVEMBER 2017
		SCHEME: SIRI TOI DAM ZHOB RIVER BASIN		Drawn By : ARSALAN RAFAT	Scale : AS SHOWN
				Checked By : ZAFAR MASOOD SIDDIQUE	Drg No :
				Approved By : DR BASHIR LAKHANI	BWRDP-ZRB-STD-PP-528

No.	Revision	By	Date



NOTE:
1. ALL DIMENSIONS & LEVELS ARE IN METER.

LEGEND:
- MAIN CANAL
- DL-1 DISTRIBUTARY CANAL
- BL-1 BRANCH CANAL
- ROAD
- CONTOUR
- RIVER
- STREAM
- COMMAND AREA
- SETTLEMENTS
- FALL STRUCTURE
- FLOW DIRECTION



DATUM

Parameter	18+000 to 18+400	18+400 to 19+500
BED SLOPE	1:250	1:1500
VELOCITY	1.86	0.95
DESIGN FLOW (CUMECS)	1.20	
CANAL TYPE	TRAPEZOIDAL	
BED WIDTH, B (m)	0.75	1.00
CANAL DEPTH, D (m)	1.01	1.23

DISTANCE (m)	BTL (m)	DBL (m)	NSL (m)
18+000	1252.617	1251.606	1253.272
18+100	1252.217 / 1250.717	1251.206 / 1249.706	1250.901
18+200	1250.317	1249.306	1248.683
18+300	1249.917 / 1247.917	1248.906 / 1246.906	1247.864
18+400	1247.517	1246.506	1247.281
18+500	1247.669 / 1244.669	1246.440 / 1243.440	1246.081
18+600	1244.602 / 1241.602	1243.373 / 1240.373	1243.528
18+700	1241.535	1240.306	1239.321
18+800	1241.469	1240.240	1234.000
18+900	1241.402	1240.173	1235.111
19+000	1241.335	1240.106	1235.992
19+100	1241.275 / 1241.268	1240.046 / 1240.040	1240.188
19+200	1241.202	1239.973	1240.427
19+300	1241.135	1239.906	1240.451
19+400	1241.069	1239.840	1240.177
19+500	1241.002	1239.773	1239.697

HORIZONTAL
0 50 100 200
m

VERTICAL (PROFILE)
0 5 10 20
m

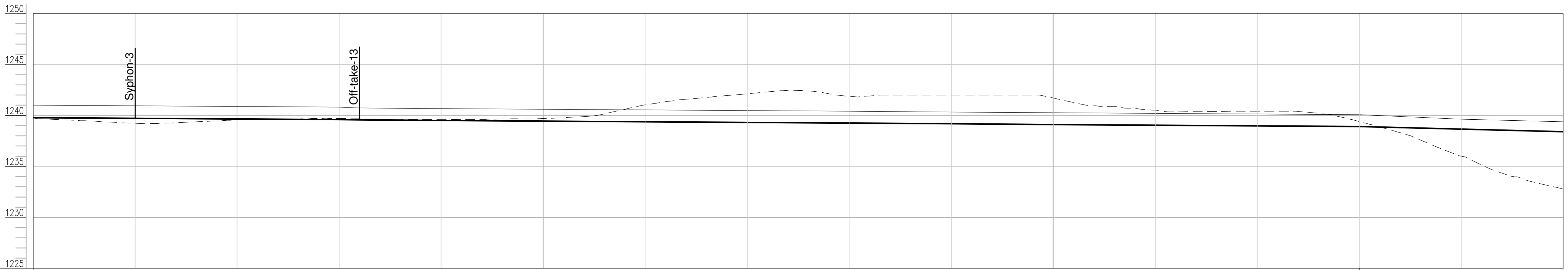
CLIENT:	CONSTRUCTION SUPERVISION:	PROJECT:	DRAWING TITLE:		
ASIAN DEVELOPMENT BANK	Techno-Consult International (Pvt.) Ltd.	BALOCHISTAN WATER RESOURCES DEVELOPMENT PROJECT (TA)	LEFT CANAL PLAN & PROFILE AT 18+000 TO 19+500	Designed By: MEHROZ AFTAB	Date: NOVEMBER 2017
		SCHEME: SIRI TOI DAM ZHOB RIVER BASIN		Drawn By: ARSALAN RAFAT	Scale: AS SHOWN
				Checked By: ZAFAR MASOOD SIDDIQUE	Drg No:
				Approved By: DR BASHIR LAKHANI	BWRDP-ZRB-STD-PP-529

No.	Revision	By	Date

NOTE:
1. ALL DIMENSIONS & LEVELS ARE IN METER.

LEGEND:

- MAIN CANAL
- DL−1 DISTRIBUTARY CANAL
- BL−1 BRANCH CANAL
- ROAD
- 1400 CONTOUR
- RIVER
- STREAM
- COMMAND AREA
- SETTLEMENTS
- FALL STRUCTURE
- FLOW DIRECTION

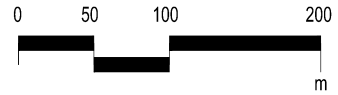


DATUM

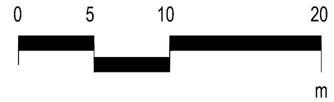
Parameter	19+500 to 19+800	19+800 to 20+800	20+800 to 21+000
BED SLOPE	1:1500	1:1500	1:400
VELOCITY	0.95	0.86	1.41
DESIGN FLOW (CUMECS)	1.20	0.80	0.80
CANAL TYPE	TRAPEZOIDAL	TRAPEZOIDAL	TRAPEZOIDAL
BED WIDTH, B (m)	1.00	0.75	0.75
CANAL DEPTH, D (m)	1.23	1.16	0.97

DISTANCE (m)	BTL (m)	DBL (m)	NSL (m)
19+500	1241.002	1239.773	1239.697
19+600	1240.935	1239.706	1239.221
19+700	1240.869	1239.640	1239.555
19+800	1240.802 / 1240.718	1239.573 / 1239.560	1239.689
19+900	1240.665	1239.506	1239.593
20+000 20+000	1240.598	1239.440	1239.691
20+100	1240.531	1239.373	1241.026
20+200	1240.465	1239.306	1242.121
20+300	1240.398	1239.240	1241.877
20+400	1240.331	1239.173	1241.992
20+500	1240.265	1239.106	1241.698
20+600	1240.198	1239.040	1240.515
20+700	1240.131	1238.973	1240.411
20+800	1240.065	1238.906	1239.401
20+900	1239.623	1238.656	1235.984
21+000	1239.373	1238.406	1232.783

HORIZONTAL



VERTICAL (PROFILE)



CLIENT : ADB ASIAN DEVELOPMENT BANK

CONSTRUCTION SUPERVISION: Techno-Consult International (Pvt.)Ltd.

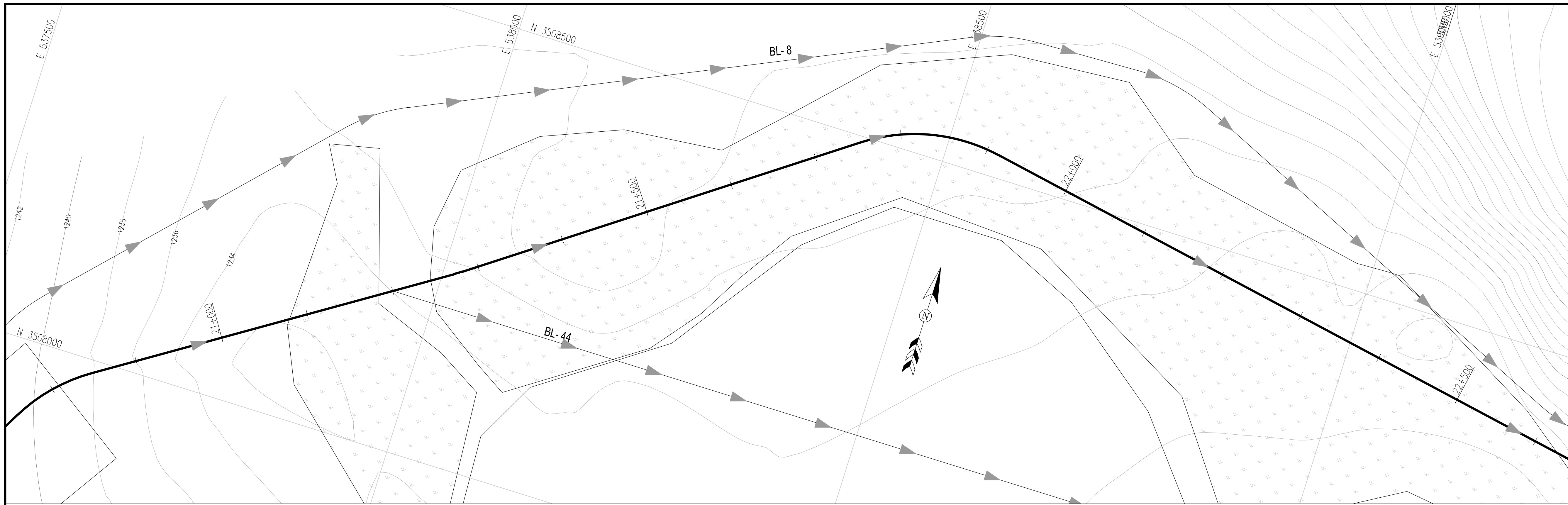
PROJECT: BALOCHISTAN WATER RESOURCES DEVELOPMENT PROJECT (TA)

SCHEME: SIRI TOI DAM ZHOB RIVER BASIN

DRAWING TITLE : LEFT CANAL PLAN & PROFILE AT 19+500 TO 21+000

Designed By :	MEHROZ AFTAB	Date :	NOVEMBER 2017
Drawn By :	ARSALAN RAFAT	Scale :	AS SHOWN
Checked By :	ZAFAR MASOOD SIDDIQUE	Drg No :	
Approved By :	DR BASHIR LAKHANI		BWRDP-ZRB-STD-PP-530

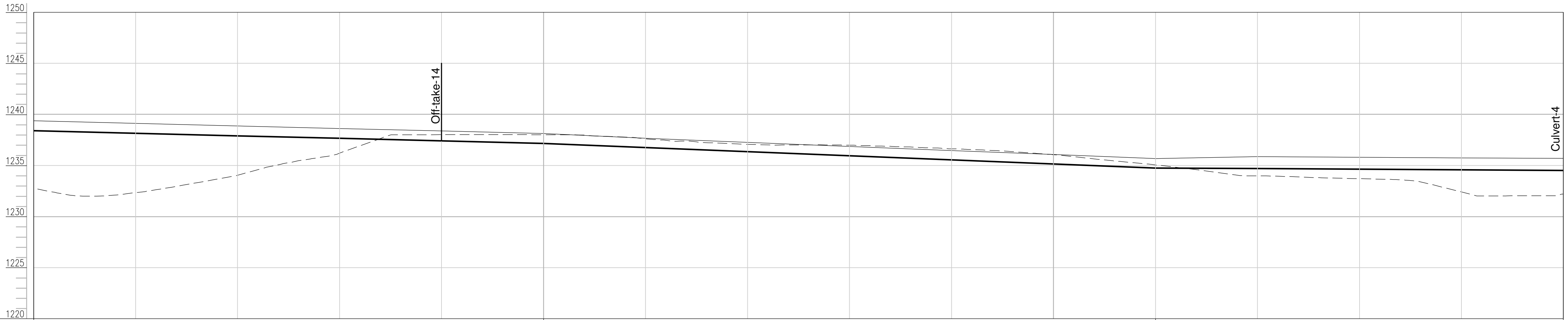
No.	Revision	By	Date



NOTE:
1. ALL DIMENSIONS & LEVELS ARE IN METER.

LEGEND:

- MAIN CANAL
- DL–1 DISTRIBUTARY CANAL
- BL–1 BRANCH CANAL
- ROAD
- 1400 CONTOUR
- RIVER
- STREAM
- COMMAND AREA
- SETTLEMENTS
- FALL STRUCTURE
- FLOW DIRECTION



DATUM

	21+000 to 21+500	21+500 to 22+100	22+100 to 22+500
BED SLOPE	1:400	1:250	1:1650
VELOCITY	1.41	1.67	0.83
DESIGN FLOW (CUMECS)	0.80	0.80	0.80
CANAL TYPE	TRAPEZOIDAL	TRAPEZOIDAL	TRAPEZOIDAL
BED WIDTH, B (m)	0.75	0.75	0.75
CANAL DEPTH, D (m)	0.97	0.91	1.17

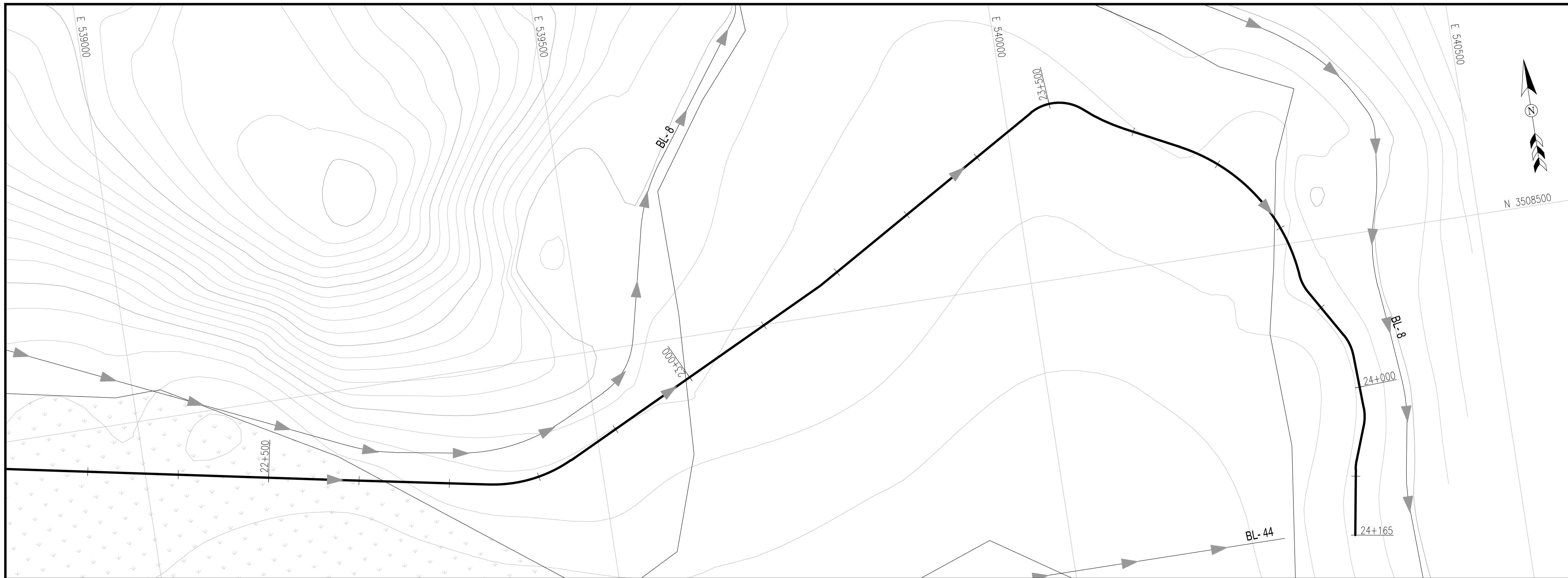
DISTANCE (m)	BTL (m)	DBL (m)	NSL (m)
21+000	1239.373	1238.406	1232.783
21+100	1239.123	1238.156	1232.341
21+200	1238.873	1237.906	1234.044
21+300	1238.623	1237.656	1236.207
21+400	1238.373	1237.406	1238.013
21+500	1238.123	1237.156	1238.010
21+600	1237.668	1236.756	1237.615
21+700	1237.268	1236.356	1237.067
21+800	1236.868	1235.956	1236.979
21+900	1236.468	1235.556	1236.630
22+000	1236.068	1235.156	1236.057
22+100	1235.668	1234.756	1235.053
22+200	1235.870	1234.696	1233.985
22+300	1235.810	1234.635	1233.708
22+400	1235.749	1234.575	1232.406
22+500	1235.688	1234.514	1232.222

HORIZONITAL
0 50 100 200
m

VERTICAL (PROFILE)
0 5 10 20
m

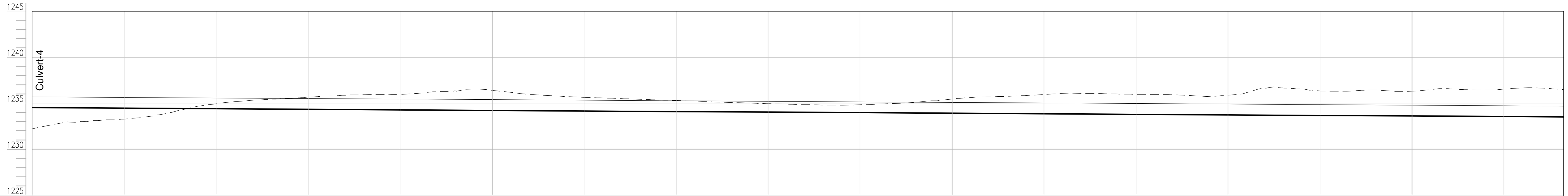
CLIENT : ADB ASIAN DEVELOPMENT BANK	CONSTRUCTION SUPERVISION: Techno-Consult International (Pvt.)Ltd.	PROJECT: BALOCHISTAN WATER RESOURCES DEVELOPMENT PROJECT (TA)	DRAWING TITLE : LEFT CANAL PLAN & PROFILE AT 21+000 TO 22+500	Designed By : MEHROZ AFTAB	Date : NOVEMBER 2017
		SCHEME: SIRI TOI DAM ZHOB RIVER BASIN		Drawn By : ARSALAN RAFAT	Scale : AS SHOWN
				Checked By : ZAFAR MASOOD SIDDIQUE	Drg No :
				Approved By : DR BASHIR LAKHANI	BWRDP-ZRB-STD-PP-531

No.	Revision	By	Date



NOTE:
1. ALL DIMENSIONS & LEVELS ARE IN METER.

LEGEND:
- MAIN CANAL
- DL-1 DISTRIBUTARY CANAL
- BL-1 BRANCH CANAL
- ROAD
- 1400 CONTOUR
- RIVER
- STREAM
- COMMAND AREA
- SETTLEMENTS
- FALL STRUCTURE
- FLOW DIRECTION



DATUM

BED SLOPE	1:1650
VELOCITY	0.83
DESIGN FLOW (CUMECS)	0.80
CANAL TYPE	TRAPEZOIDAL
BED WIDTH, B (m)	0.75
CANAL DEPTH, D (m)	1.17

DISTANCE (m)	22+500	22+600	22+700	22+800	22+900	23+000	23+100	23+200	23+300
BTL (m)	1235.688	1235.628	1235.567	1235.507	1235.446	1235.385	1235.325	1235.264	1235.203
DBL (m)	1234.514	1234.453	1234.393	1234.332	1234.271	1234.211	1234.150	1234.090	1234.029
NSL (m)	1232.222	1233.274	1234.939	1235.664	1235.965	1236.390	1235.634	1235.296	1234.946

DISTANCE (m)	23+400	23+500	23+600	23+700	23+800	23+900	24+000	24+100	24+165
BTL (m)	1235.143	1235.082	1235.022	1234.961	1234.900	1234.840	1234.779	1234.719	1234.679
DBL (m)	1233.968	1233.908	1233.847	1233.787	1233.726	1233.665	1233.605	1233.544	1233.505
NSL (m)	1234.828	1235.447	1235.943	1235.968	1235.864	1236.317	1236.307	1236.529	1236.529

HORIZONITAL
0 50 100 200
m

VERTICAL (PROFILE)
0 5 10 20
m

CLIENT : ASIAN DEVELOPMENT BANK	CONSTRUCTION SUPERVISION: Techno-Consult International (Pvt.)Ltd.	PROJECT: BALOCHISTAN WATER RESOURCES DEVELOPMENT PROJECT (TA)	DRAWING TITLE : LEFT CANAL PLAN & PROFILE AT 22+500 TO 24+165	
		SCHEME: SIRI TOI DAM ZHOB RIVER BASIN		

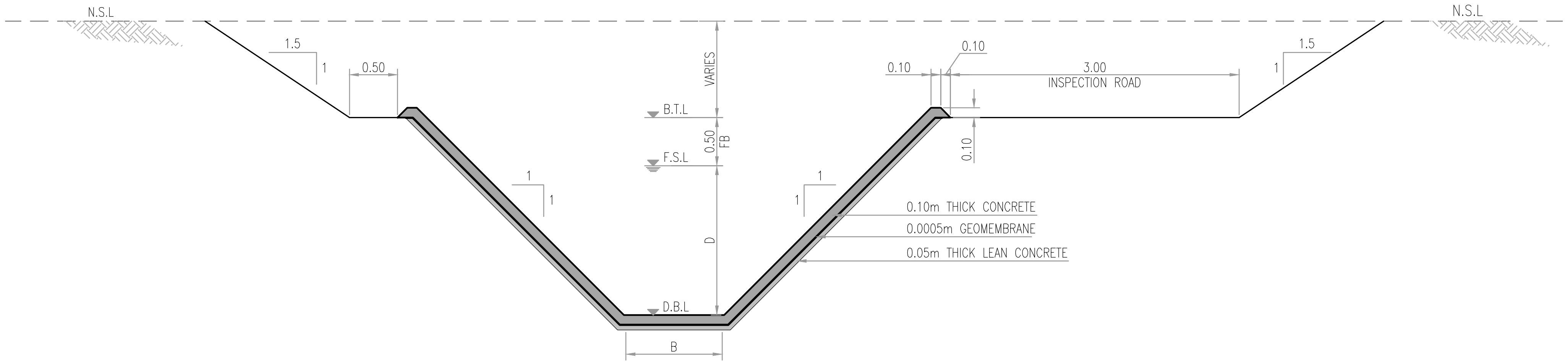
Designed By :	MEHROZ AFTAB	Date :	NOVEMBER 2017
Drawn By :	ARSALAN RAFAT	Scale :	AS SHOWN
Checked By :	ZAFAR MASOOD SIDDIQUE	Drg No :	
Approved By :	DR BASHIR LAKHANI		BWRDP-ZRB-STD-PP-532

No.	Revision	By	Date

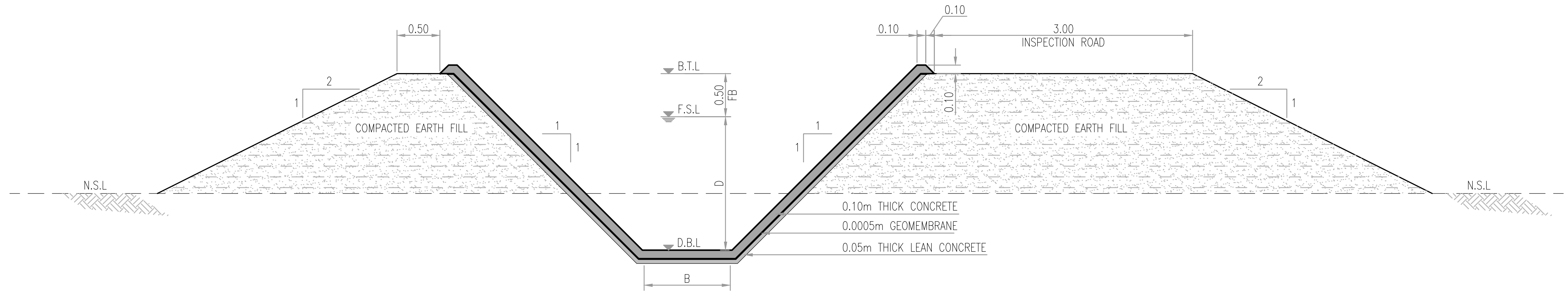
SIRI TOI DAM

IRRIGATION CANAL
APPURTENANT STRUCTURES

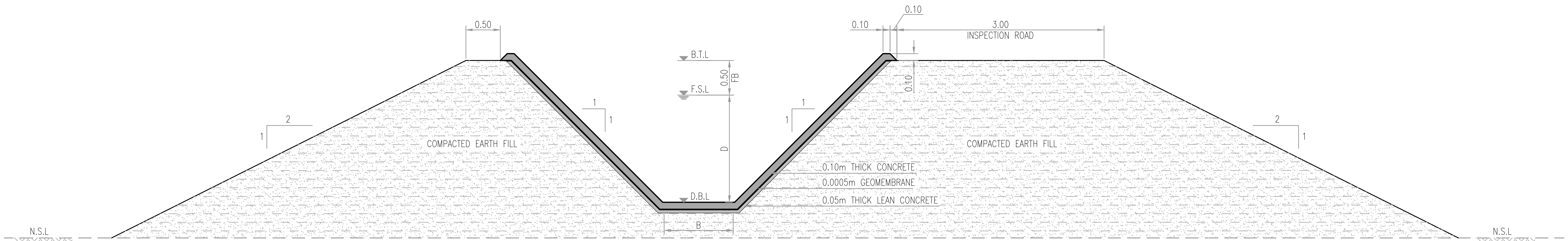
NOTE:
1. ALL DIMENSIONS & LEVELS ARE IN METER.



CUT SECTION



CUT & FILL SECTION



FILL SECTION

SCALE
0 1 2 3
m

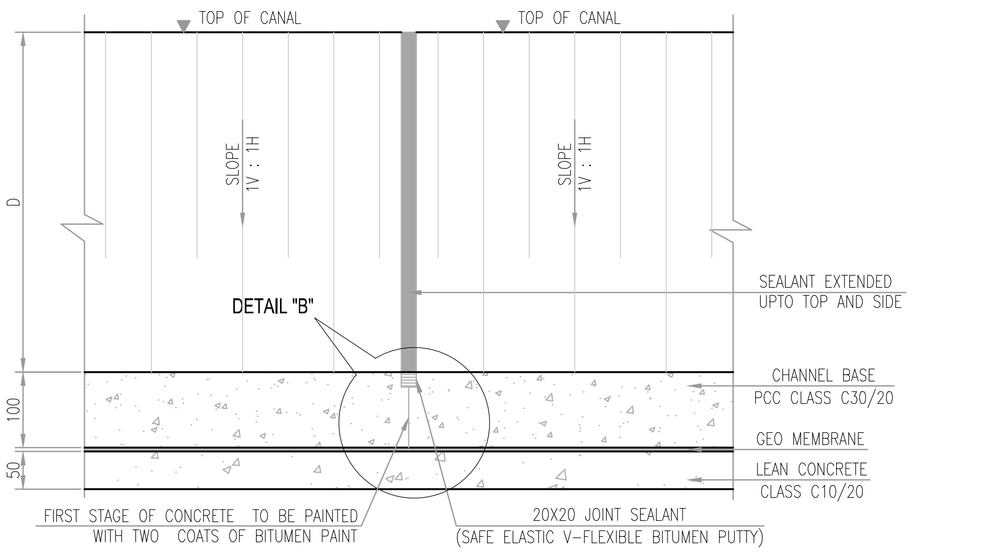
CLIENT : ADB ASIAN DEVELOPMENT BANK	CONSULTANT: Techno-Consult International (Pvt.)Ltd.	PROJECT: BALOCHISTAN WATER RESOURCES DEVELOPMENT PROJECT (TA)	DRAWING TITLE : CANAL TYPICAL CROSS SECTION	Designed By : SAAD-UR-REHMAN	Date : NOVEMBER 2017	No.	Revision / By / Date
		SCHEME: SIRI TOI DAM ZHOB RIVER BASIN		Drawn By : ARSALAN RAFAT	Scale : AS SHOWN		
				Checked By : ZAFAR MASOOD SIDDIQUE	Drg No :		
				Approved By : DR BASHIR LAKHANI	BWRDP-ZRB-STD-ST-601		

NOTE:

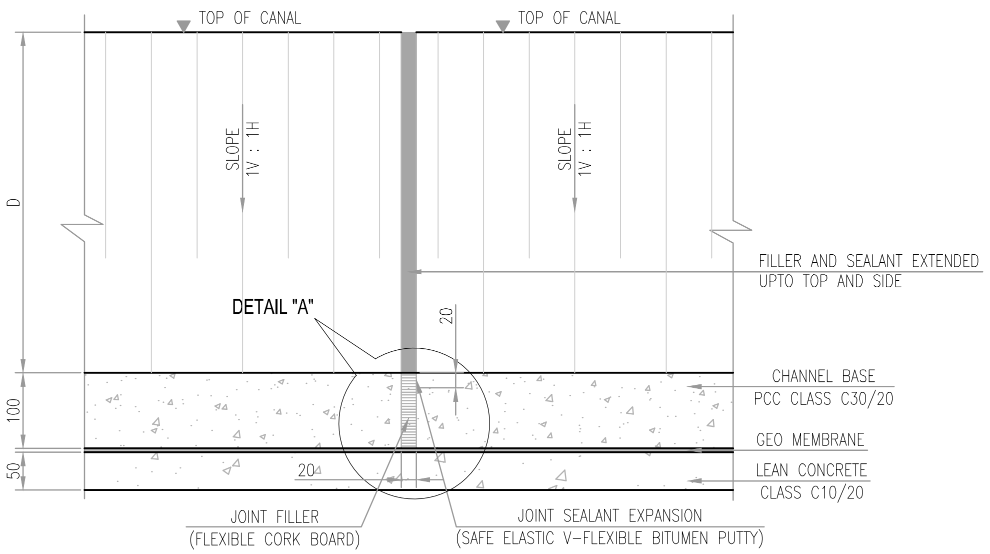
1. ALL DIMENSIONS/ELEVATIONS ARE IN MILLIMETER.
2. CONTRACTION JOINTS TO BE PROVIDED AT EVERY 3 METER.
3. EXPANSION JOINTS TO BE PROVIDED AT EVERY STRUCTURE INTERFACE OR AT 25 METER INTERVAL OTHER WISE.
4. CHANNEL WALLS AT EXPANSION JOINTS OR THAT ABUT WITH STRUCTURES TO BE OF CONCRETE CLASS B.
5. FOR VALUES OF B & D REFER TO LONGITUDINAL SECTION

LEGEND:

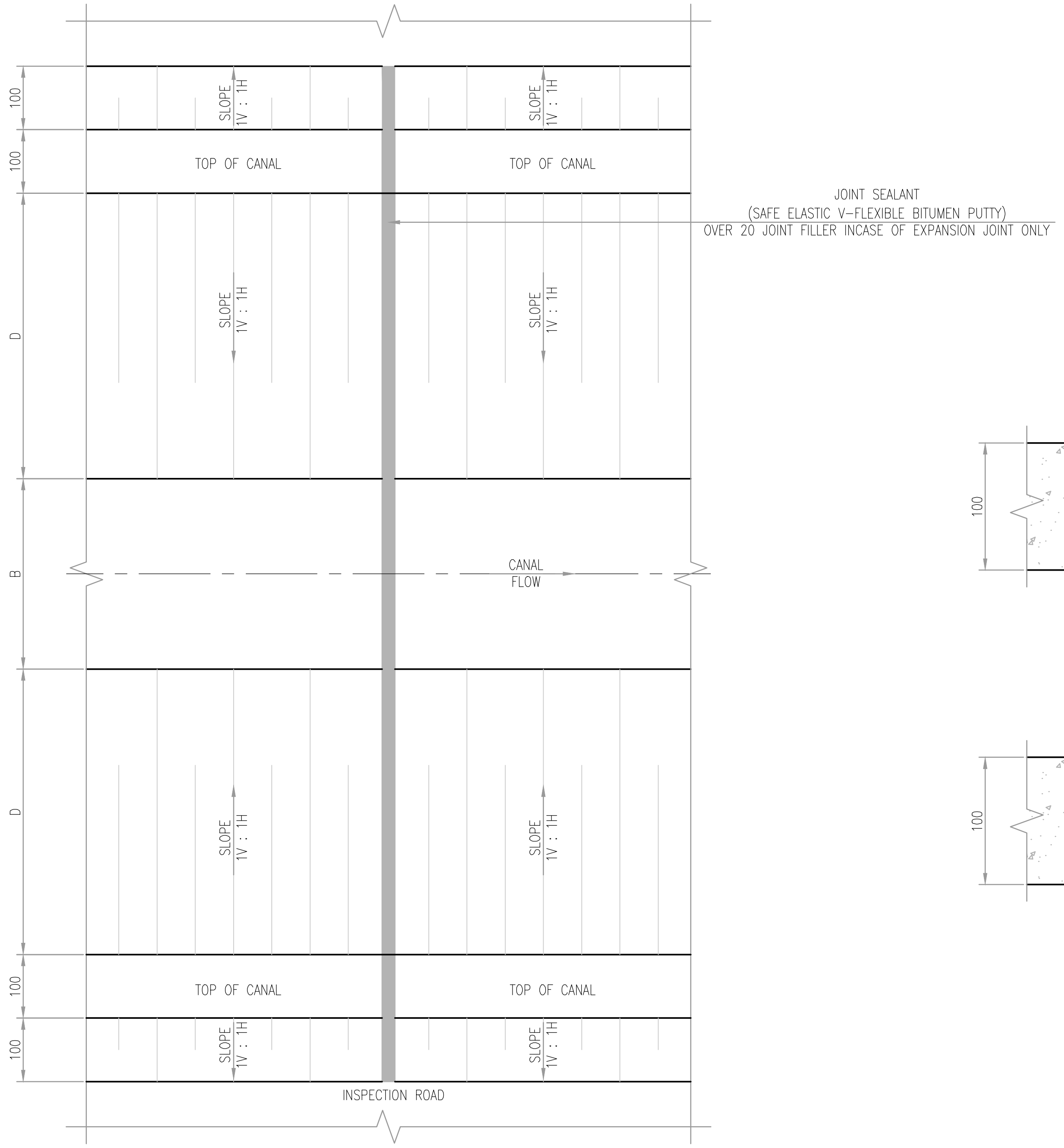
B	BED WIDTH
D	CHANNEL DEPTH



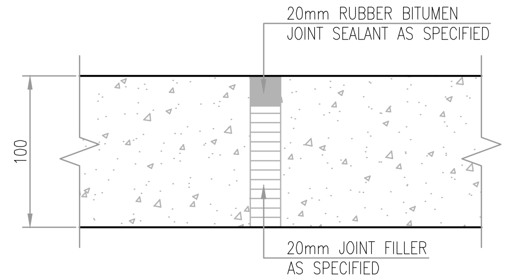
LONGITUDINAL SECTION
CONTRACTION JOINT



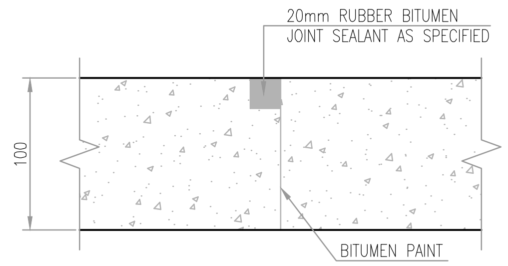
LONGITUDINAL SECTION
EXPANSION JOINT



PLAN
EXPANSION AND CONTRACTION JOINTS



DETAIL "A"
SCALE-B



DETAIL "B"
SCALE-B

SCALE:- A
0 100 200 300 400 500 m

SCALE:- B
0 50 100 150 200 250 m

CLIENT : ADB ASIAN DEVELOPMENT BANK	CONSULTANT: Techno-Consult International (Pvt.)Ltd.	PROJECT: BALOCHISTAN WATER RESOURCES DEVELOPMENT PROJECT (TA)	DRAWING TITLE : CONTRACTION AND EXPANSION JOINT DETAILS	
		SCHEME: SIRI TOI DAM ZHOB RIVER BASIN		

Designed By :	ABDUL HAI	Date :	NOVEMBER 2017
Drawn By :	ARSALAN RAFAT	Scale :	AS SHOWN
Checked By :	ZAFAR MASOOD SIDDIQUE	Drg No :	
Approved By :	DR BASHIR LAKHANI		BWRDP-ZRB-STD-ST-602

No.	Revision	By	Date

NOTE:

1. ALL DIMENSIONS ARE IN MILLIMETERS.

SCALE

0 500 1000 1500

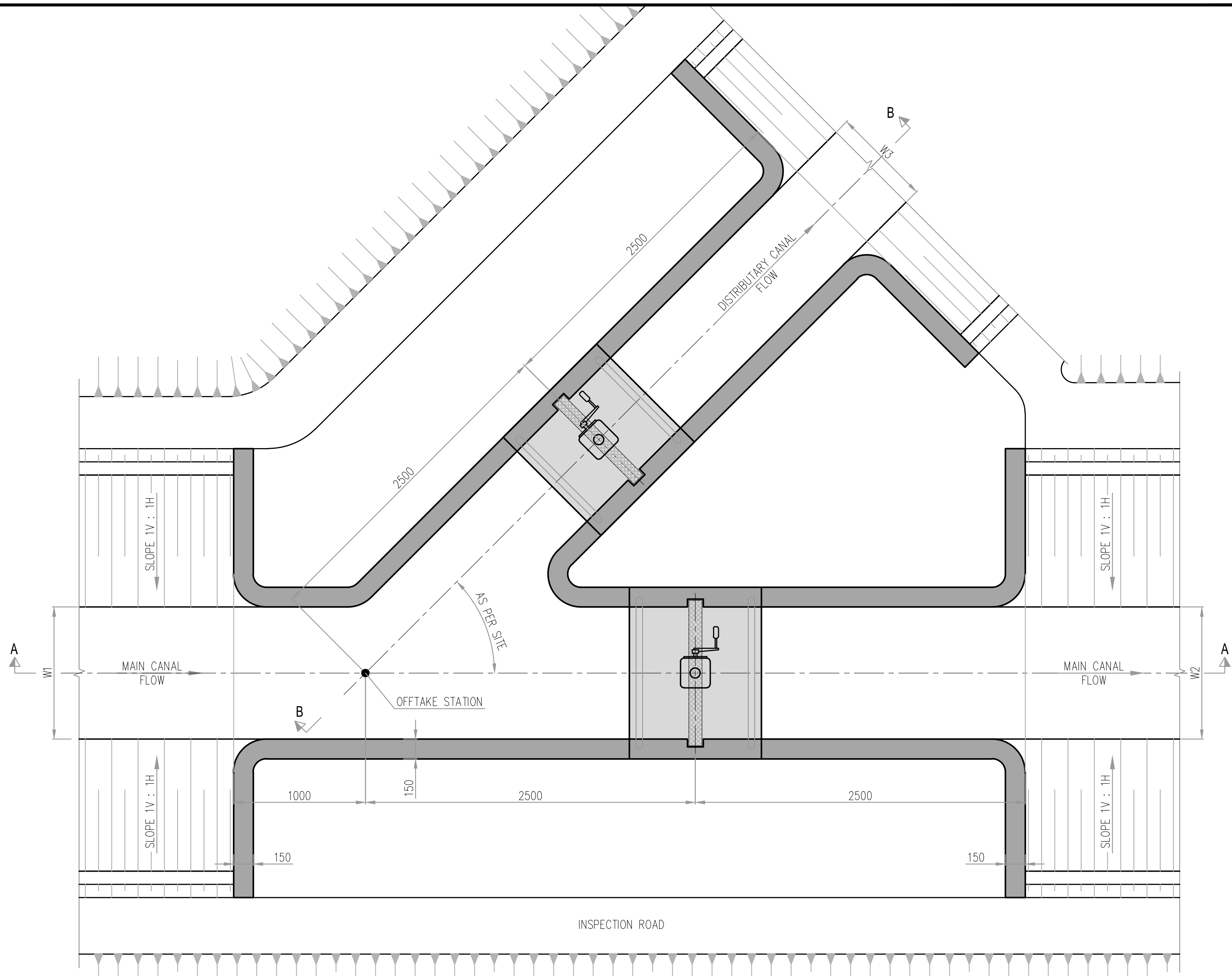
mm

RIGHT CANAL

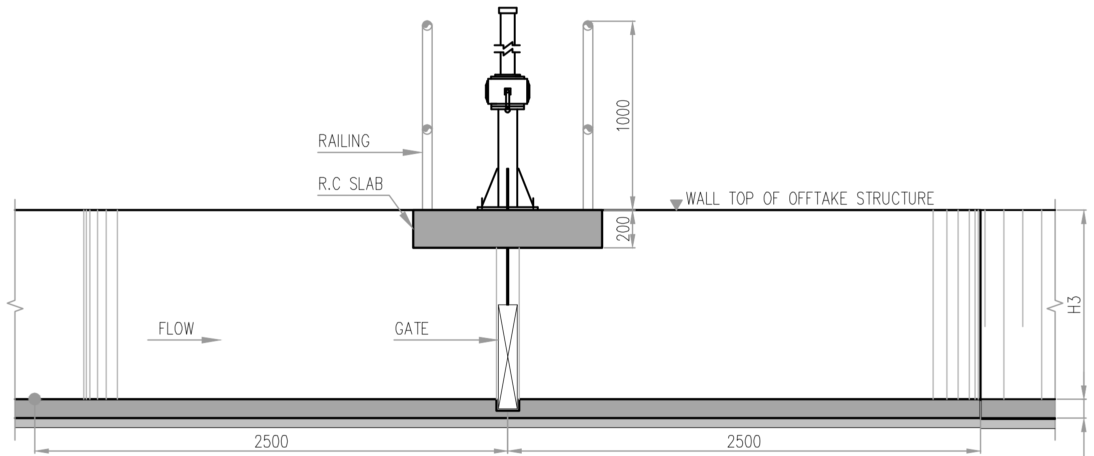
Chainage	W1 (mm)	W2 (mm)	W3 (mm)	H1 (mm)	H2 (mm)	H3 (mm)
0+227	750	750	500	1200	1200	300
2+632	750	750	150	1200	1200	150
2+661	750	750	500	1200	1200	300
3+819	750	750	500	1000	1000	350
5+813	750	750	500	1200	1200	300
9+041	750	750	200	1200	1200	200
10+425	750	750	500	1200	1200	300
10+612	750	750	150	1000	1000	150
10+924	750	750	150	1000	1000	150
11+234	750	750	300	1000	1000	300
14+300	750	750	200	1000	1000	200
14+310	750	750	200	1000	1000	200
15+650	750	750	200	1000	1000	200
17+250	750	750	200	1000	1000	200
18+400	750	750	200	1200	1200	200
19+420	750	750	200	1200	1200	200
19+430	750	750	200	1200	1200	200
19+700	750	750	200	1200	1200	200

LEFT CANAL

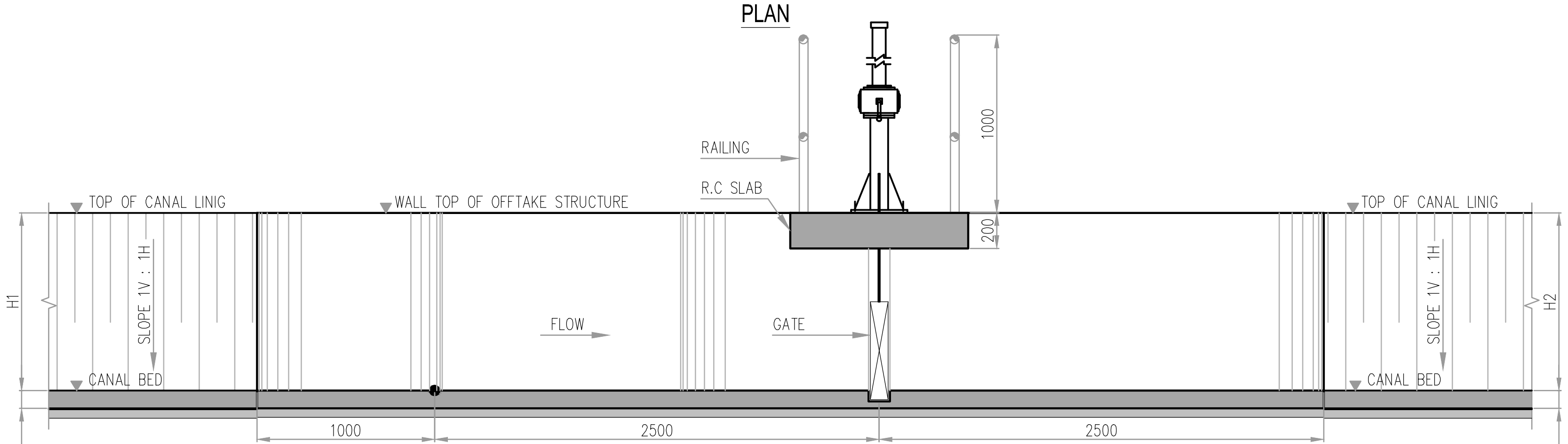
Chainage	W1 (mm)	W2 (mm)	W3 (mm)	H1 (mm)	H2 (mm)	H3 (mm)
2+100	1000	1000	750	1500	1500	750
5+120	1000	1000	250	1000	1000	250
5+780	1000	1000	250	1000	1000	250
7+680	1000	1000	250	1000	1000	250
7+800	1000	1000	250	1000	1000	250
9+400	1000	1000	250	1500	1500	250
12+060	1000	1000	500	1500	1300	500
16+000	750	750	250	1200	1000	250
17+800	750	750	250	1000	1000	250
18+400	750	750	250	1200	1000	250
19+090	1000	1000	250	1300	1300	250
19+100	1000	1000	250	1300	1300	250
19+820	1000	750	750	1300	1200	500
21+400	750	750	250	1000	1000	250



PLAN



SECTION B-B



SECTION A-A

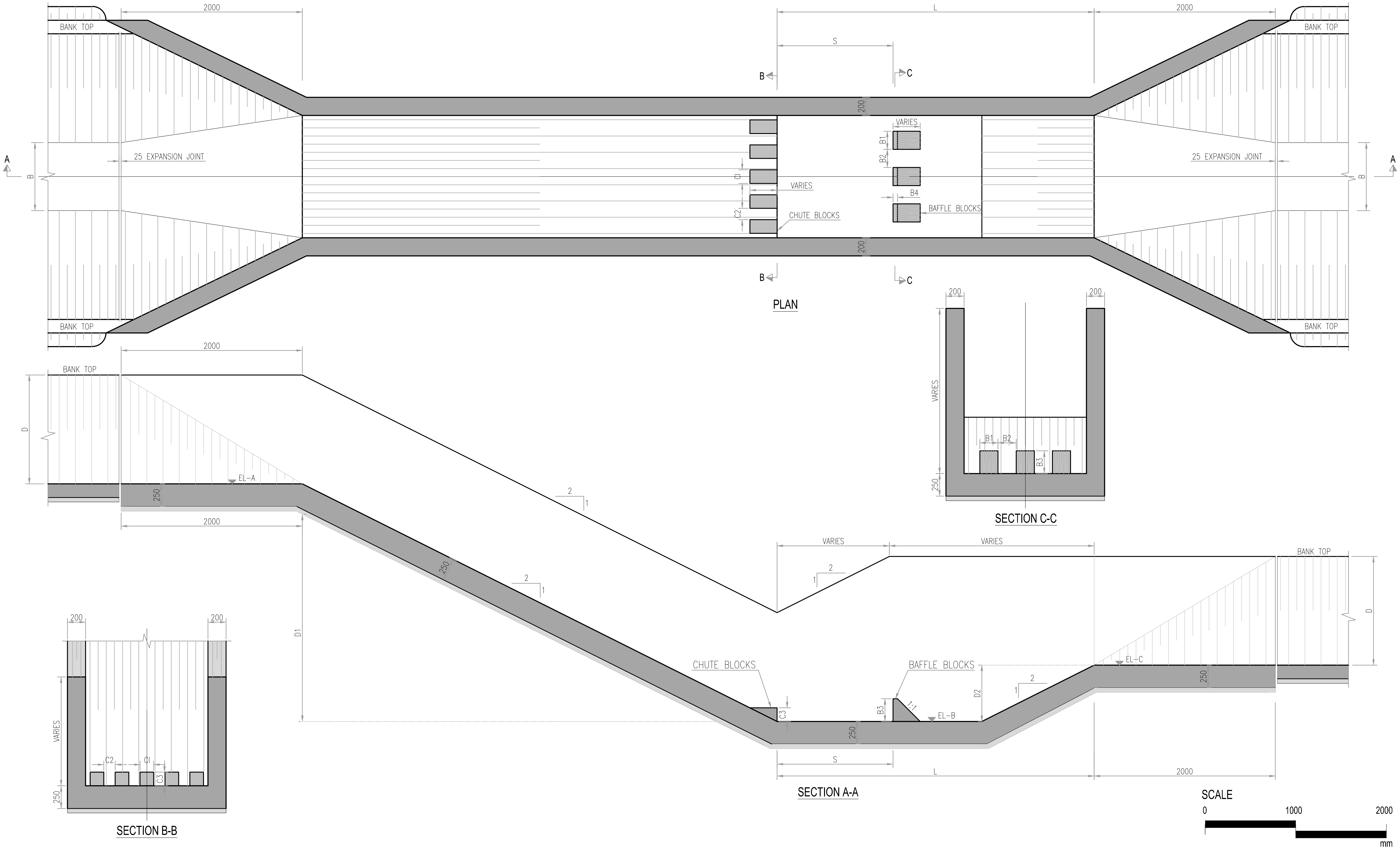
CLIENT: ADB ASIAN DEVELOPMENT BANK	CONSULTANT: Techno-Consult International (Pvt.)Ltd.	PROJECT: BALOCHISTAN WATER RESOURCES DEVELOPMENT PROJECT (TA)	DRAWING TITLE: OFFTAKE STRUCTURE	
		SCHEME: SIRI TOI DAM ZHOB RIVER BASIN		

Designed By :	MEHROZ AFTAB	Date :	NOVEMBER 2017
Drawn By :	ARSALAN RAFAT	Scale :	AS SHOWN
Checked By :	ZAFAR MASOOD SIDDIQUE	Drg No :	
Approved By :	DR BASHIR LAKHANI		BWRDP-ZRB-STD-ST-603

No.	Revision	By	Date

NOTE:

1. ALL DIMENSIONS ARE IN MILLIMETERS & LEVELS ARE IN METER.



CLIENT :	CONSULTANT:	PROJECT:	DRAWING TITLE :		
ADB ASIAN DEVELOPMENT BANK	Techno-Consult International (Pvt.)Ltd.	BALOCHISTAN WATER RESOURCES DEVELOPMENT PROJECT (TA) SCHEME: SIRI TOI DAM ZHOB RIVER BASIN	PLAN AND SECTION FALL STRUCTURE	Designed By : MEHROZ AFTAB Drawn By : ARSALAN RAFAT Checked By : ZAFAR MASOOD SIDDIQUE Approved By : DR BASHIR LAKHANI	Date : NOVEMBER 2017 Scale : AS SHOWN Drg No : BWRDP-ZRB-STD-ST-604

No.	Revision	By	Date

LEFT CANAL

Chainage	L (m)	D_1 (m)	D_2 (m)	C_1 (m)	C_2 (m)	C_3 (m)	B_1 (m)	B_2 (m)	B_3 (m)	B_4 (m)	S (m)	EL. A	EL. B	EL. C
3+400	2.0	0.6	0.1	0.20	0.20	0.20	0.25	0.2	0.05	0.2	1.0	1394.20	1393.62	1393.70
4+700	3.5	3.7	0.7	0.15	0.15	0.15	0.25	0.2	0.05	0.2	1.5	1391.20	1387.46	1388.20
4+800	3.5	3.7	0.7	0.15	0.15	0.15	0.25	0.2	0.05	0.2	1.5	1387.80	1384.06	1384.80
4+900	3.0	2.6	0.6	0.20	0.20	0.20	0.25	0.2	0.05	0.2	1.0	1384.40	1381.78	1382.40
5+000	3.5	3.7	0.7	0.15	0.15	0.15	0.25	0.2	0.05	0.2	1.5	1382.00	1378.26	1379.00
5+100	3.5	3.7	0.7	0.15	0.15	0.15	0.25	0.2	0.05	0.2	1.5	1378.60	1374.86	1375.60
5+200	3.5	3.2	0.7	0.15	0.15	0.15	0.25	0.2	0.05	0.2	1.5	1375.20	1372.01	1372.70
5+400	3.5	3.7	0.7	0.15	0.15	0.15	0.25	0.2	0.05	0.2	1.5	1371.90	1368.16	1368.90
5+500	3.5	3.7	0.7	0.15	0.15	0.15	0.25	0.2	0.05	0.2	1.5	1368.50	1364.76	1365.50
5+600	3.0	2.6	0.6	0.20	0.20	0.20	0.25	0.2	0.05	0.2	1.0	1365.10	1362.48	1363.10
5+700	3.5	3.7	0.7	0.15	0.15	0.15	0.25	0.2	0.05	0.2	1.5	1362.70	1358.96	1359.70
5+800	2.5	1.4	0.4	0.25	0.25	0.25	0.3	0.2	0.1	0.2	1.0	1359.30	1357.85	1358.30
6+900	3.0	2.0	0.5	0.20	0.20	0.20	0.25	0.2	0.05	0.2	1.0	1355.25	1353.20	1353.75
7+000	3.5	3.7	0.7	0.15	0.15	0.15	0.25	0.2	0.05	0.2	1.5	1353.35	1349.61	1350.35
7+100	3.0	2.6	0.6	0.20	0.20	0.20	0.25	0.2	0.05	0.2	1.0	1349.95	1347.33	1347.95
7+150	3.0	2.0	0.5	0.20	0.20	0.20	0.25	0.2	0.05	0.2	1.0	1347.75	1345.70	1346.25
7+200	3.5	3.7	0.7	0.15	0.15	0.15	0.25	0.2	0.05	0.2	1.5	1346.05	1342.31	1343.05
7+250	3.0	2.6	0.6	0.20	0.20	0.20	0.25	0.2	0.05	0.2	1.0	1342.85	1340.23	1340.85
7+300	3.5	3.7	0.7	0.15	0.15	0.15	0.25	0.2	0.05	0.2	1.5	1340.65	1336.91	1337.65
7+350	3.0	2.6	0.6	0.20	0.20	0.20	0.25	0.2	0.05	0.2	1.0	1337.45	1334.83	1335.45
7+400	3.5	3.7	0.7	0.15	0.15	0.15	0.25	0.2	0.05	0.2	1.5	1335.25	1331.51	1332.25
7+450	3.5	3.7	0.7	0.15	0.15	0.15	0.25	0.2	0.05	0.2	1.5	1332.05	1328.31	1329.05
7+500	3.0	2.6	0.6	0.20	0.20	0.20	0.25	0.2	0.05	0.2	1.0	1328.85	1326.23	1326.85
7+550	3.0	2.6	0.6	0.20	0.20	0.20	0.25	0.2	0.05	0.2	1.0	1326.65	1324.03	1324.65
7+600	2.0	0.8	0.3	0.25	0.25	0.25	0.3	0.25	0.1	0.25	1.0	1324.45	1323.64	1323.95
7+650	3.0	2.6	0.6	0.20	0.20	0.20	0.25	0.2	0.05	0.2	1.0	1323.75	1321.13	1321.75
7+700	3.0	2.6	0.6	0.20	0.20	0.20	0.25	0.2	0.05	0.2	1.0	1321.55	1318.93	1319.55
12+350	2.5	1.9	0.4	0.15	0.15	0.15	0.25	0.2	0.05	0.2	1.0	1308.02	1306.09	1306.52
12+400	3.0	2.5	0.5	0.15	0.15	0.15	0.25	0.2	0.05	0.2	1.0	1306.39	1303.90	1304.39
12+450	2.5	1.3	0.3	0.20	0.20	0.20	0.25	0.2	0.05	0.2	1.0	1304.27	1302.93	1303.27
12+600	2.5	1.3	0.3	0.20	0.20	0.20	0.25	0.2	0.05	0.2	1.0	1302.89	1301.55	1301.89
12+900	3.0	2.6	0.6	0.15	0.15	0.15	0.25	0.2	0.05	0.2	1.0	1301.10	1298.55	1299.10
12+950	3.5	3.7	0.7	0.15	0.15	0.15	0.25	0.2	0.05	0.2	1.0	1298.94	1295.28	1295.94
13+000	3.0	2.6	0.6	0.15	0.15	0.15	0.25	0.2	0.05	0.2	1.0	1295.77	1293.22	1293.77
13+050	3.0	2.6	0.6	0.15	0.15	0.15	0.25	0.2	0.05	0.2	1.0	1293.60	1291.05	1291.60
13+100	3.5	3.7	0.7	0.15	0.15	0.15	0.25	0.2	0.05	0.2	1.0	1291.44	1287.78	1288.44
13+150	3.5	3.7	0.7	0.15	0.15	0.15	0.25	0.2	0.05	0.2	1.0	1288.27	1284.61	1285.27
13+200	2.5	2.0	0.5	0.15	0.15	0.15	0.25	0.2	0.05	0.2	1.0	1285.10	1283.12	1283.60
13+250	2.0	0.8	0.3	0.25	0.25	0.25	0.25	0.2	0.05	0.2	1.0	1283.44	1282.67	1282.94
13+500	2.5	2.0	0.5	0.15	0.15	0.15	0.25	0.2	0.05	0.2	1.0	1282.10	1280.12	1280.60
13+600	3.0	2.6	0.6	0.15	0.15	0.15	0.25	0.2	0.05	0.2	1.0	1280.27	1277.72	1278.27
16+400	2.5	1.4	0.4	0.20	0.20	0.20	0.25	0.2	0.05	0.2	1.0	1274.61	1273.18	1273.61
16+500	3.0	3.1	0.6	0.15	0.15	0.15	0.25	0.2	0.05	0.2	1.0	1273.21	1270.06	1270.71
16+600	3.5	3.7	0.7	0.15	0.15	0.15	0.25	0.2	0.05	0.2	1.0	1270.31	1266.61	1267.31
16+700	3.0	3.1	0.6	0.15	0.15	0.15	0.25	0.2	0.05	0.2	1.0	1266.91	1263.76	1264.41
16+800	2.5	2.0	0.5	0.15	0.15	0.15	0.25	0.2	0.05	0.2	1.0	1264.01	1261.99	1262.51
16+900	3.0	3.1	0.6	0.15	0.15	0.15	0.25	0.2	0.05	0.2	1.0	1262.11	1258.96	1259.61
17+300	3.0	2.6	0.6	0.15	0.15	0.15	0.25	0.2	0.05	0.2	1.0	1258.01	1255.42	1256.01
17+600	2.5	1.2	0.2	0.15	0.15	0.15	0.2	0.15	0.05	0.15	1.0	1255.71	1254.54	1254.71
17+700	2.5	2.0	0.5	0.15	0.15	0.15	0.25	0.2	0.05	0.2	1.0	1254.31	1252.29	1252.81
18+100	2.5	2.0	0.5	0.15	0.15	0.15	0.25	0.2	0.05	0.2	1.0	1251.21	1249.19	1249.71
18+300	3.0	2.6	0.6	0.15	0.15	0.15	0.25	0.2	0.05	0.2	1.0	1248.91	1246.32	1246.91
18+500	3.0	3.3	0.3	0.10	0.10	0.10	0.2	0.15	0.05	0.15	1.0	1246.44	1243.12	1243.44
18+600	3.0	3.3	0.3	0.10	0.10	0.10	0.2	0.15	0.05	0.15	1.0	1243.37	1240.05	1240.37

RIGHT CANAL

Chainage	L (m)	D_1 (m)	D_2 (m)	C_1 (m)	C_2 (m)	C_3 (m)	B_1 (m)	B_2 (m)	B_3 (m)	B_4 (m)	S (m)	EL. A	EL. B	EL. C
0+100	3.5	3.2	0.7	0.15	0.15	0.15	0.20	0.20	0.25	0.05	1.5	1400.63	1397.44	1398.13
2+800	3.0	2.6	0.6	0.15	0.15	0.15	0.20	0.20	0.25	0.05	1.0	1395.15	1392.56	1393.15
3+000	3.0	2.6	0.6	0.15	0.15	0.15	0.20	0.20	0.25	0.05	1.0	1392.35	1389.76	1390.35
3+100	3.0	2.6	0.6	0.15	0.15	0.15	0.20	0.20	0.25	0.05	1.0	1389.95	1387.36	1387.95
3+200	3.5	3.7	0.7	0.15	0.15	0.15	0.20	0.20	0.25	0.05	1.0	1387.55	1383.85	1384.55
3+400	3.0	2.6	0.6	0.15	0.15	0.15	0.20	0.20	0.25	0.05	1.0	1383.75	1381.16	1381.75
3+500	3.5	3.7	0.7	0.15	0.15	0.15	0.20	0.20	0.25	0.05	1.0	1381.35	1377.65	1378.35
3+600	3.0	3.1	0.6	0.15	0.15	0.15	0.20	0.20	0.25	0.05	1.0	1377.95	1374.80	1375.45
3+900	2.5	2.0	0.5	0.15	0.15	0.15	0.20	0.20	0.25	0.05	1.0	1374.25	1372.25	1372.75
4+000	3.0	2.6	0.6	0.15	0.15	0.15	0.20	0.20	0.25	0.05	1.0	1372.35	1369.79	1370.35
4+100	3.0	2.6	0.6	0.15	0.15	0.15	0.20	0.20	0.25	0.05	1.0	1369.95	1367.39	1367.95
4+200	2.0	1.4	0.4	0.20	0.20	0.20	0.20	0.20	0.25	0.05	1.0	1367.55	1366.14	1366.55
4+300	2.5	2.0	0.5	0.15	0.15	0.15	0.20	0.20	0.25	0.05	1.0	1366.15	1364.15	1364.65
4+400	2.0	1.4	0.4	0.20	0.20	0.20	0.20	0.20	0.25	0.05	1.0	1364.25	1362.84	1363.25
4+500	2.5	2.0	0.5	0.15	0.15	0.15	0.20	0.20	0.25	0.05	1.0	1362.85	1360.85	1361.35
4+600	2.0	1.4	0.4	0.20	0.20	0.20	0.20	0.20	0.25	0.05	1.0	1360.95	1359.54	1359.95
4+700	2.0	1.4	0.4	0.20	0.20	0.20	0.20	0.20	0.25	0.05	1.0	1359.55	1358.14	1358.55
5+500	2.0	1.0	0.0	0.15	0.15	0.15	0.15	0.15	0.20	0.05	1.0	1357.80	1356.75	1356.80
5+600	2.5	2.2	0.2	0.10	0.10	0.10	0.15	0.15	0.20	0.05	1.0	1356.75	1354.59	1354.75
5+900	3.0	3.6	0.6	0.10	0.10	0.10	0.15	0.15	0.20	0.05	1.0	1354.29	1350.67	1351.29
6+100	3.0	2.5	0.5	0.15	0.15	0.15	0.15	0.15	0.20	0.05	1.0	1350.62	1348.10	1348.62
6+300	3.0	2.5	0.5	0.15	0.15	0.15	0.15	0.15	0.20	0.05	1.0	1347.96	1345.44	1345.96
6+400	2.0	1.4	0.4	0.15	0.15	0.15	0.15	0.15	0.20	0.05	1.0	1345.62	1344.25	1344.62
6+500	2.5	2.0	0.5	0.15	0.15	0.15	0.15	0.15	0.20	0.05	1.0	1344.29	1342.34	1342.79
6+600	3.0	3.6	0.6	0.10	0.10	0.10	0.15	0.15	0.20	0.05	1.0	1342.46	1338.84	1339.46
7+200	2.5	2.0	0.5	0.15	0.15	0.15	0.15	0.15	0.20	0.05	1.0	1337.46	1335.50	1335.96
7+300	2.5	2.0	0.5	0.15	0.15	0.15	0.15	0.15	0.20	0.05	1.0	1335.62	1333.67	1334.12
7+400	2.0	1.4	0.4	0.15	0.15	0.15	0.15	0.15	0.20	0.05	1.0	1333.79	1332.42	1332.79
8+700	2.0	1.0	0.2	0.15	0.15	0.15	0.15	0.15	0.20	0.05	1.0	1330.86	1329.87	1330.11
8+800	3.0	3.5	0.5	0.10	0.10	0.10	0.15	0.15	0.20	0.05	1.0	1329.91	1326.38	1326.91
8+900	2.0	1.3	0.3	0.15	0.15	0.15	0.15	0.15	0.20	0.05	1.0	1326.71	1325.42	1325.71
9+100	3.0	3.5	0.5	0.10	0.10	0.10	0.15	0.15	0.20	0.05	1.0	1325.31	1321.78	1322.31
9+200	2.5	2.4	0.4	0.15	0.15	0.15	0.15	0.15	0.20	0.05	1.0	1322.11	1319.68	1320.11
9+400	2.5	2.4	0.4	0.15	0.15	0.15	0.15	0.15	0.20	0.05	1.0	1319.71	1317.28	1317.71
9+500	3.0	3.5	0.5	0.10	0.10	0.10	0.15	0.15	0.20	0.05	1.0	1317.51	1313.98	1314.51
9+600	3.0	3.5	0.5	0.10	0.10	0.10	0.15	0.15	0.20	0.05	1.0	1314.31	1310.78	1311.31
9+650	2.5	2.4	0.4	0.15	0.15	0.15	0.15	0.15	0.20	0.05	1.0	1311.21	1308.78	1309.21
10+500	2.5	2.1	0.1	0.10	0.10	0.10	0.15	0.15	0.20	0.05	1.0	1308.27	1306.13	1306.27
10+800	3.0	3.5	0.5	0.10	0.10	0.10	0.15	0.15	0.20	0.05	1.0	1305.92	1302.38	1302.92
11+000	2.5	2.4	0.4	0.10	0.10	0.10	0.15	0.15	0.20	0.05	1.0	1302.42	1299.97	1300.42
11+300	3.0	3.0	0.5	0.10	0.10	0.10	0.15	0.15	0.20	0.05	1.0	1299.67	1296.68	1297.17
11+400	2.5	2.4	0.4	0.10	0.10	0.10	0.15	0.15	0.20	0.05	1.0	1296.92	1294.48	1294.92
11+800	3.0	3.6	0.6	0.10	0.10	0.10	0.15	0.15	0.20	0.05	1.0	1293.77	1290.16	1290.77
11+900	2.5	2.5	0.5	0.10	0.10	0.10	0.15	0.15	0.20	0.05	1.0	1290.37	1287.86	1288.37
12+000	2.0	1.4	0.4	0.15	0.15	0.15	0.15	0.15	0.20	0.05	1.0	1287.97	1286.60	1286.97
12+200	3.0	3.6	0.6	0.10	0.10	0.10	0.15	0.15	0.20	0.05	1.0	1286.17	1282.56	1283.17
12+700	3.0	3.6	0.6	0.10	0.10	0.10	0.15	0.15	0.20	0.05	1.0	1281.17	1277.56	1278.17
12+800	2.5	2.5	0.5	0.10	0.10	0.10	0.15	0.15	0.20	0.05	1.0	1277.77	1275.26	1275.77
13+100	2.5	2.5	0.5	0.10	0.10	0.10	0.15	0.15	0.20	0.05	1.0	1274.57	1272.06	1272.57
13+400	2.0	1.4	0.4	0.15	0.15	0.15	0.15	0.15	0.20	0.05	1.0	1271.37	1270.00	1270.37
13+500	2.5	2.5	0.5	0.10	0.10	0.10	0.15	0.15	0.20	0.05	1.0	1269.97	1267.46	1267.97
14+400	2.0	1.4	0.4	0.15	0.15	0.15	0.15	0.15	0.20	0.05	1.0	1264.37	1263.00	1263.37
14+700	2.5	1.9	0.4	0.15	0.15	0.15	0.15	0.15	0.20	0.05	1.0	1262.17	1260.22	1260.67
15+000	2.0	1.4	0.4	0.15	0.15	0.15	0.15	0.15	0.20	0.05	1.0	1259.47	1258.10	1258.47
15+200	2.0	1.4	0.4	0.15	0.15	0.15	0.15	0.15	0.20	0.05	1.0	1257.67	1256.30	1256.67
15+500	2.5	2.5	0.5	0.10	0.10	0.10	0.15	0.15	0.20	0.05	1.0	1255.47	1252.96	1253.47
15+600	2.0	1.4	0.4	0.15	0.15	0.15	0.15	0.15	0.20	0.05	1.0	1253.07	1251.70	1252.07
15+700	2.0	1.4	0.4	0.15	0.15	0.15	0.15	0.15	0.20	0.05	1.0	1251.67	1250.30	1250.67
15+900	2.5	2.5	0.5	0.10	0.10	0.10	0.15	0.15	0.20	0.05	1.0	1249.87	1247.36	1247.87
16+200	2.5	2.5	0.5	0.10	0.10	0.10	0.15	0.15	0.20	0.05	1.0	1246.67	1244.16	1244.67
16+500	2.5	2.5	0.5	0.10	0.10	0.10	0.15	0.15	0.20	0.05	1.0	1243.47	1240.96	1241.47
16+700	2.5	2.5	0.5	0.10	0.10	0.10	0.15	0.15	0.20	0.05	1.0	1240.67	1238.16	1238.67
17+200	2.0	1.4	0.4	0.15	0.15	0.15	0.15	0.15	0.20	0.05	1.0	1236.67	1235.30	1235.67
17+600	2.5	2.5	0.5	0.10	0.10	0.10	0.15	0.15	0.20	0.05	1.0	1234.07	1231.56	1232.07
18+100	2.0	1.4	0.4	0.15	0.15	0.15	0.15	0.15	0.20	0.05	1.0	1230.07	1228.70	1229.07
18+300	2.0	1.4	0.4	0.15	0.15	0.15	0.15	0.15	0.20	0.05	1.0	1228.27	1226.90	1227.27
19+700	1.5	0.5	0.0	0.10	0.10	0.10	0.15	0.15	0.15	0.05	0.5	1226.54	1226.01	1226.04

CLIENT : ASIAN DEVELOPMENT BANK

CONSULTANT: Techno-Consult International (Pvt.)Ltd.

PROJECT: BALOCHISTAN WATER RESOURCES DEVELOPMENT PROJECT (TA)

SCHEME: SIRI TOI DAM ZHOB RIVER BASIN

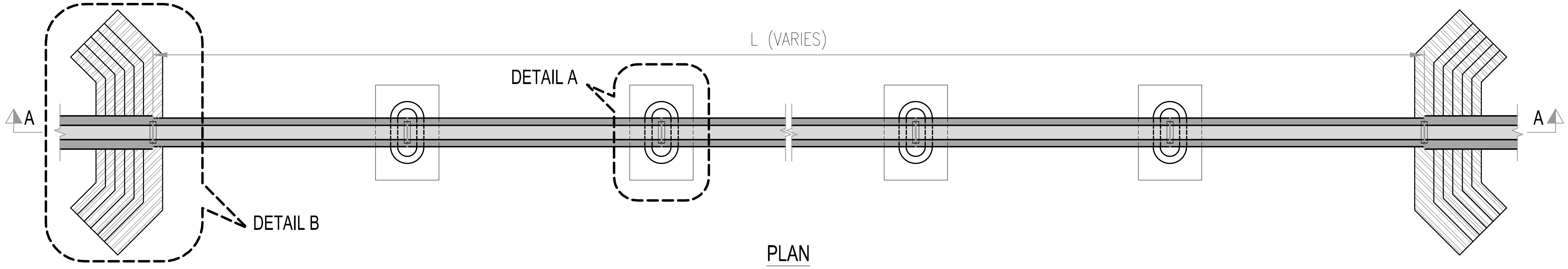
DRAWING TITLE : FALL STRUCTURE TABLE

Designed By :	MEHROZ AFTAB	Date :	NOVEMBER 2017
Drawn By :	ARSALAN RAFAT	Scale :	-
Checked By :	ZAFAR MASOOD SIDDIQUE	Drg No :	
Approved By :	DR BASHIR LAKHANI		BWRDP-ZRB-STD-ST-605

No.	Revision	By	Date

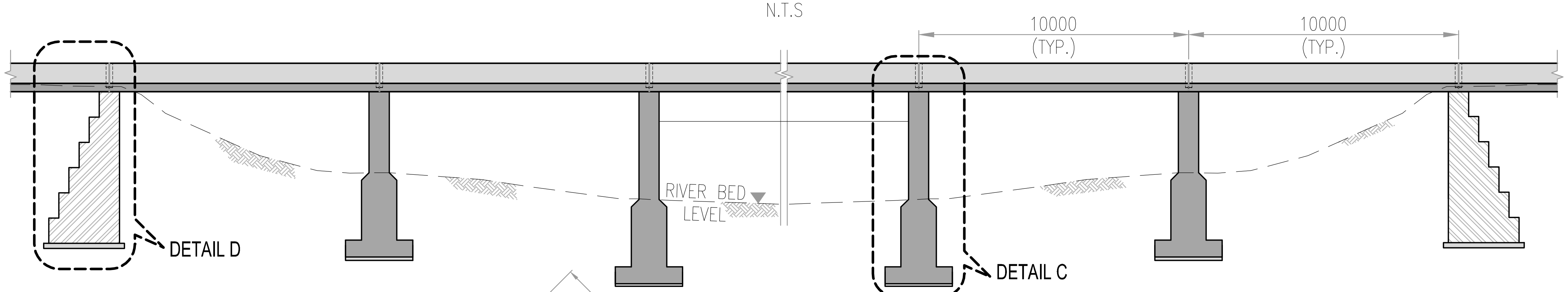
NOTE:

1. ALL DIMENSIONS ARE IN MILLIMETERS.



PLAN

N.T.S

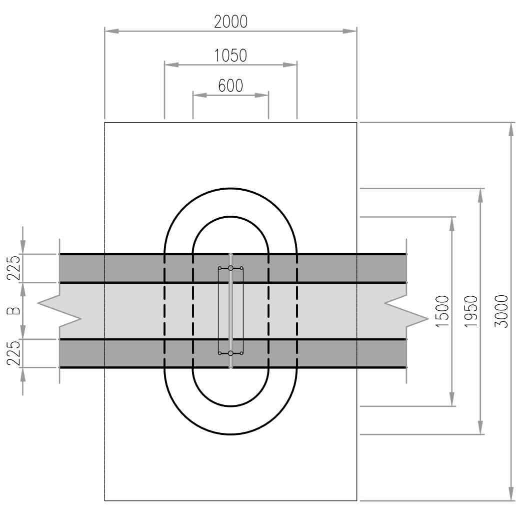


SECTION A-A

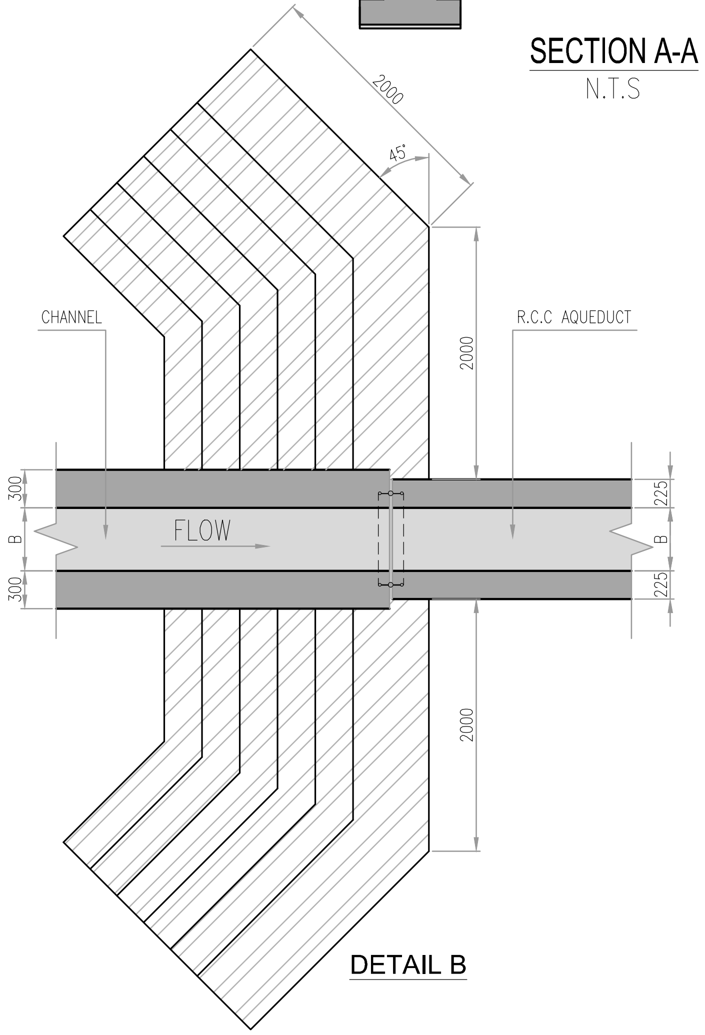
N.T.S

RIGHT CANAL					
Chainage	L (m)	No. of Pier	B (mm)	D (mm)	H (m)
12+400	100	9	1000	1000	3.00
19+100	300	29	750	750	1.00

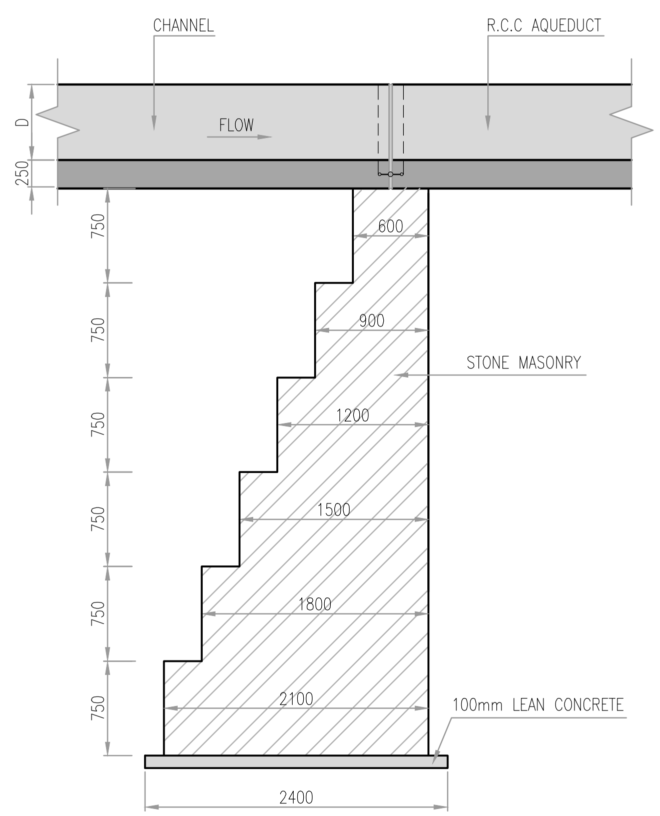
LEFT CANAL					
Chainage	L (m)	No. of Pier	B (mm)	D (mm)	H (m)
0+100	200	19	1000	750	22
2+700	100	9	1000	1000	2.30
4+500	200	19	1000	1000	10
9+000	300	29	1000	1000	9.20
18+800	300	29	1000	750	6.40
20+900	400	39	750	750	5.90



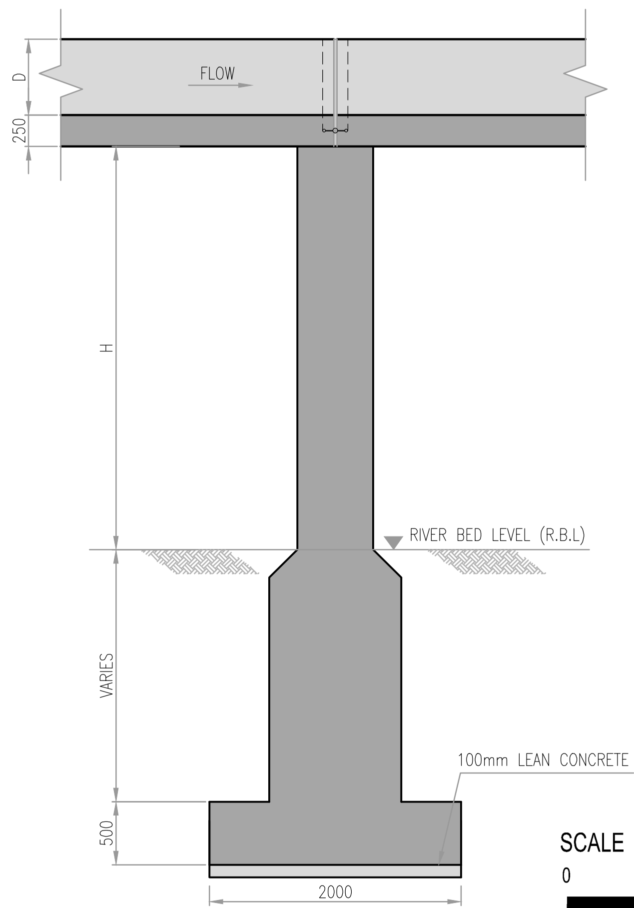
DETAIL A



DETAIL B



DETAIL D



DETAIL C

SCALE

0 1000 2000

mm

CLIENT :	CONSULTANT:	PROJECT:	DRAWING TITLE :				
ADB ASIAN DEVELOPMENT BANK	Techno-Consult International (Pvt.)Ltd.	BALOCHISTAN WATER RESOURCES DEVELOPMENT PROJECT (TA)	AQUEDUCT	Designed By :	MEHROZ AFTAB	Date :	NOVEMBER 2017
				Drawn By :	ARSALAN RAFAT	Scale :	AS SHOWN
		SCHEME: SIRI TOI DAM ZHOB RIVER BASIN		Checked By :	ZAFAR MASOOD SIDDIQUE	Drg No :	
				Approved By :	DR BASHIR LAKHANI		BWRDP-ZRB-STD-ST-606

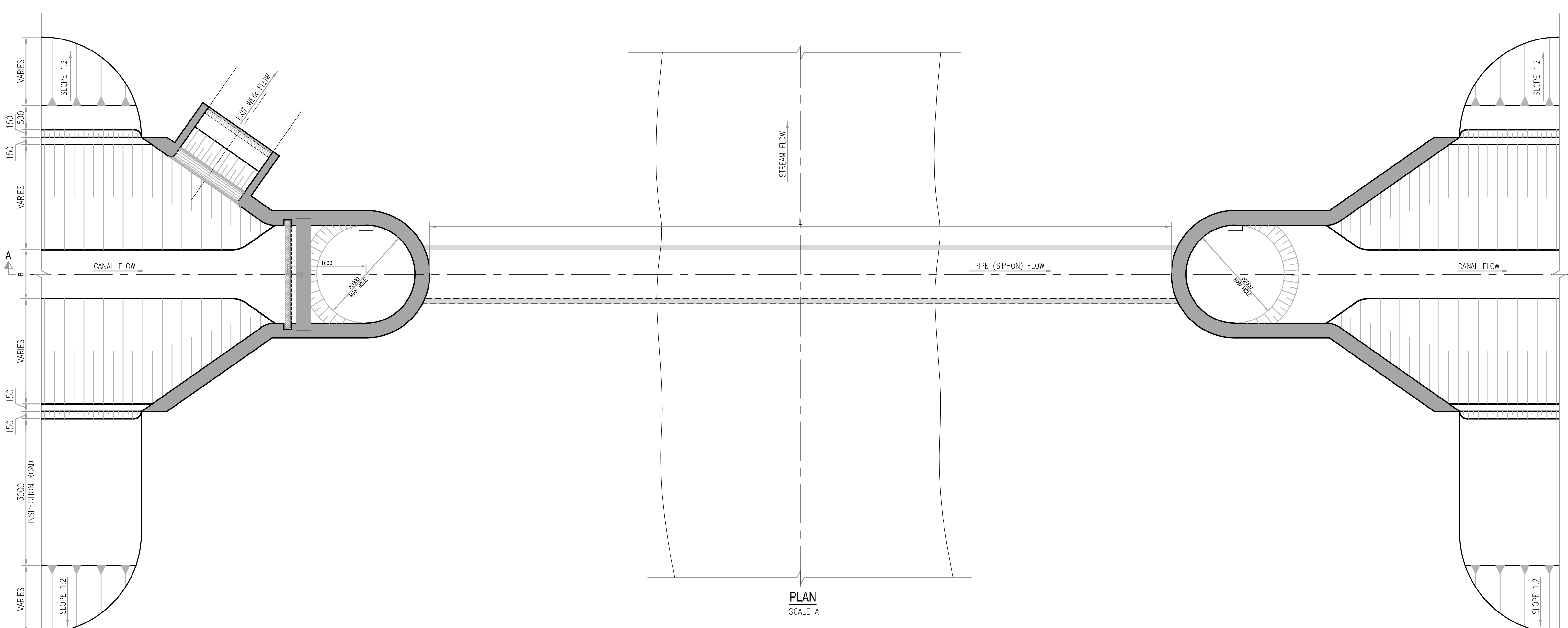
No.	Revision	By	Date

NOTE:

1. ALL DIMENSIONS ARE IN MILLIMETERS.

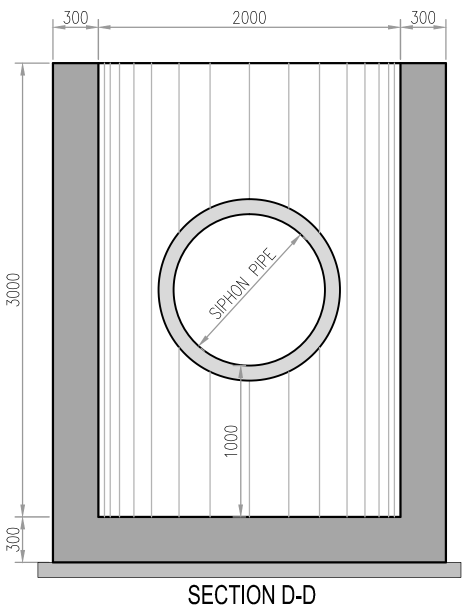
SCALE :- A — 0, 1000, 2000, 3000, 4000, 5000 mm

SCALE :- B — 0, 500, 1000, 1500, 2000, 2500 mm



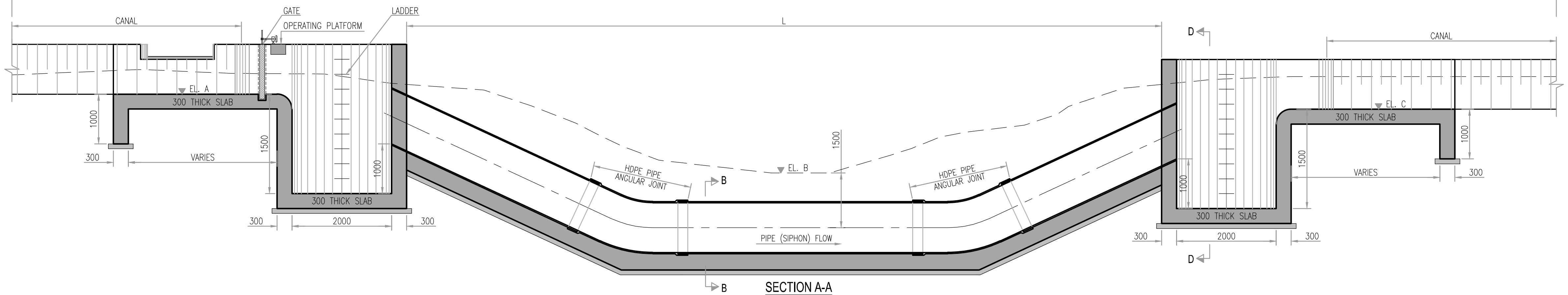
PLAN

SCALE A



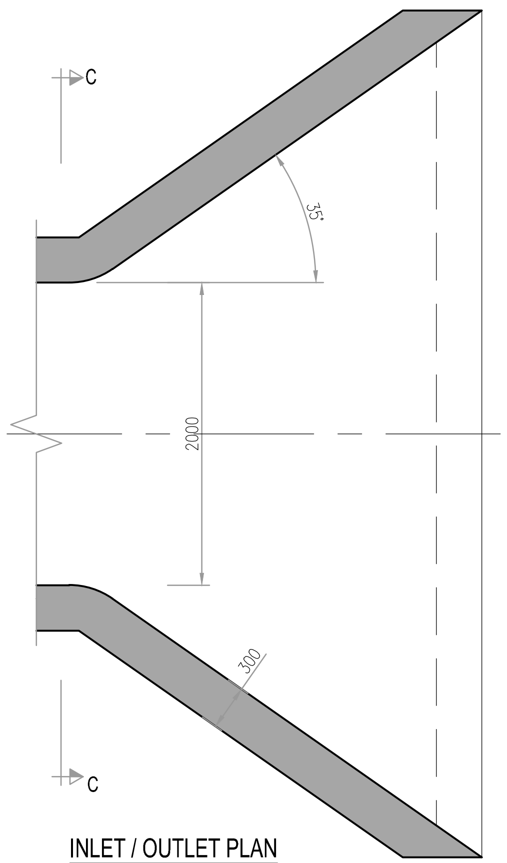
SECTION D-D

SCALE B



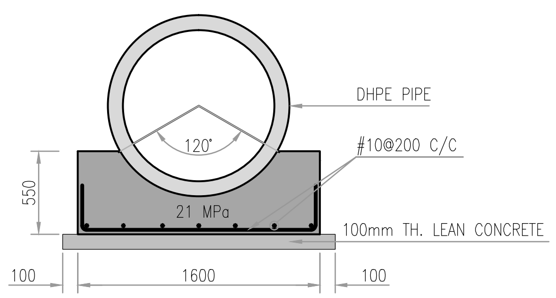
SECTION A-A

SCALE A



INLET / OUTLET PLAN

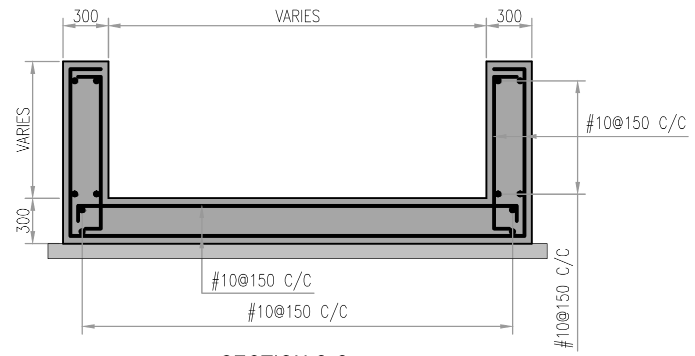
SCALE B



SECTION B-B

SCALE B

LEFT CANAL					
Chainage	D (mm)	L (m)	EL. A	EL. B	EL. C
5+280	500	20	1373.11	1373.09	1373.07
8+000	1000	700	1318.15	1313.86	1309.56
15+700	700	200	1277.01	1276.61	1276.21
19+600	600	30	1239.71	1239.67	1239.64



SECTION C-C

SCALE B

CLIENT : ADB ASIAN DEVELOPMENT BANK

CONSULTANT: Techno-Consult International (Pvt.)Ltd.

PROJECT: BALOCHISTAN WATER RESOURCES DEVELOPMENT PROJECT (TA)

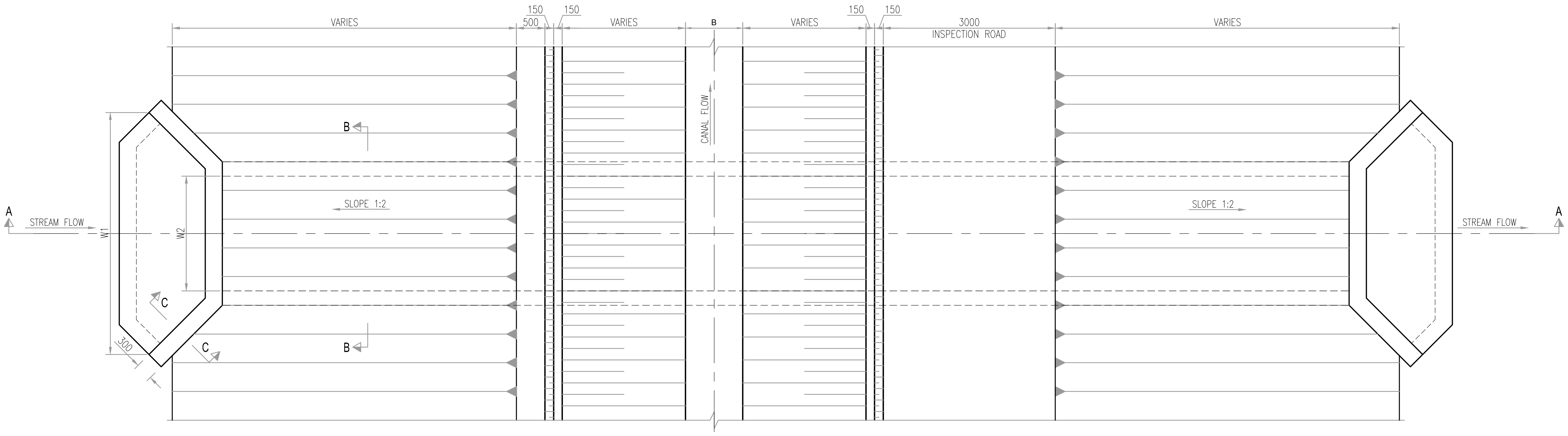
SCHEME: SIRI TOI DAM ZHOB RIVER BASIN

DRAWING TITLE : SIPHON

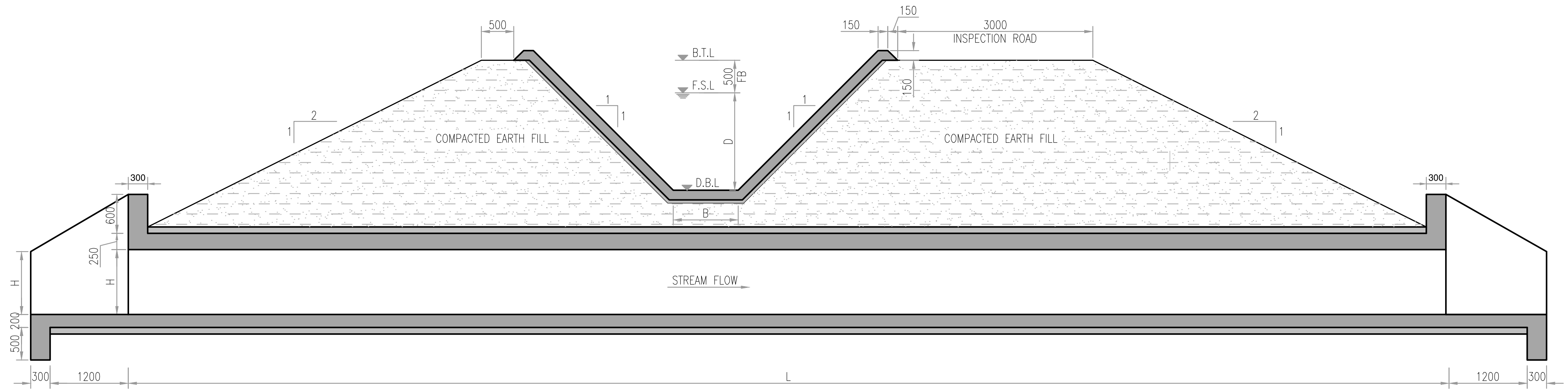
Designed By :	SAAD-UR-REHMAN	Date :	NOVEMBER 2017
Drawn By :	ARSALAN RAFAT	Scale :	AS SHOWN
Checked By :	ZAFAR MASOOD SIDDIQUE	Drg No :	
Approved By :	DR BASHIR LAKHANI		BWRDP-ZRB-STD-ST-607

No.	Revision	By	Date

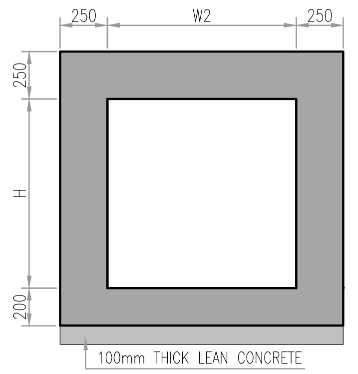
NOTE:
1. ALL DIMENSIONS ARE IN MILLIMETERS.



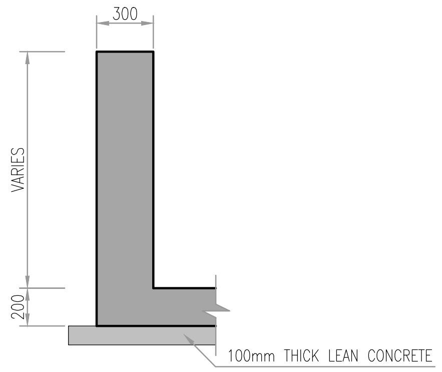
PLAN
SCALE A



SECTION A-A
SCALE A



SECTION B-B
SCALE B



SECTION C-C
SCALE B

RIGHT CANAL

Chainage	W1 (m)	W2 (m)	H (m)	L (m)
1+200	7	1	1	13
2+000	10	2	1	11
4+100	6	1	1	11
5+900	9	1.5	1	8

LEFT CANAL

Chainage	W1 (m)	W2 (m)	H (m)	L (m)
22+400	15	1	1	11

SCALE :- A
0 1000 2000 3000 4000
mm

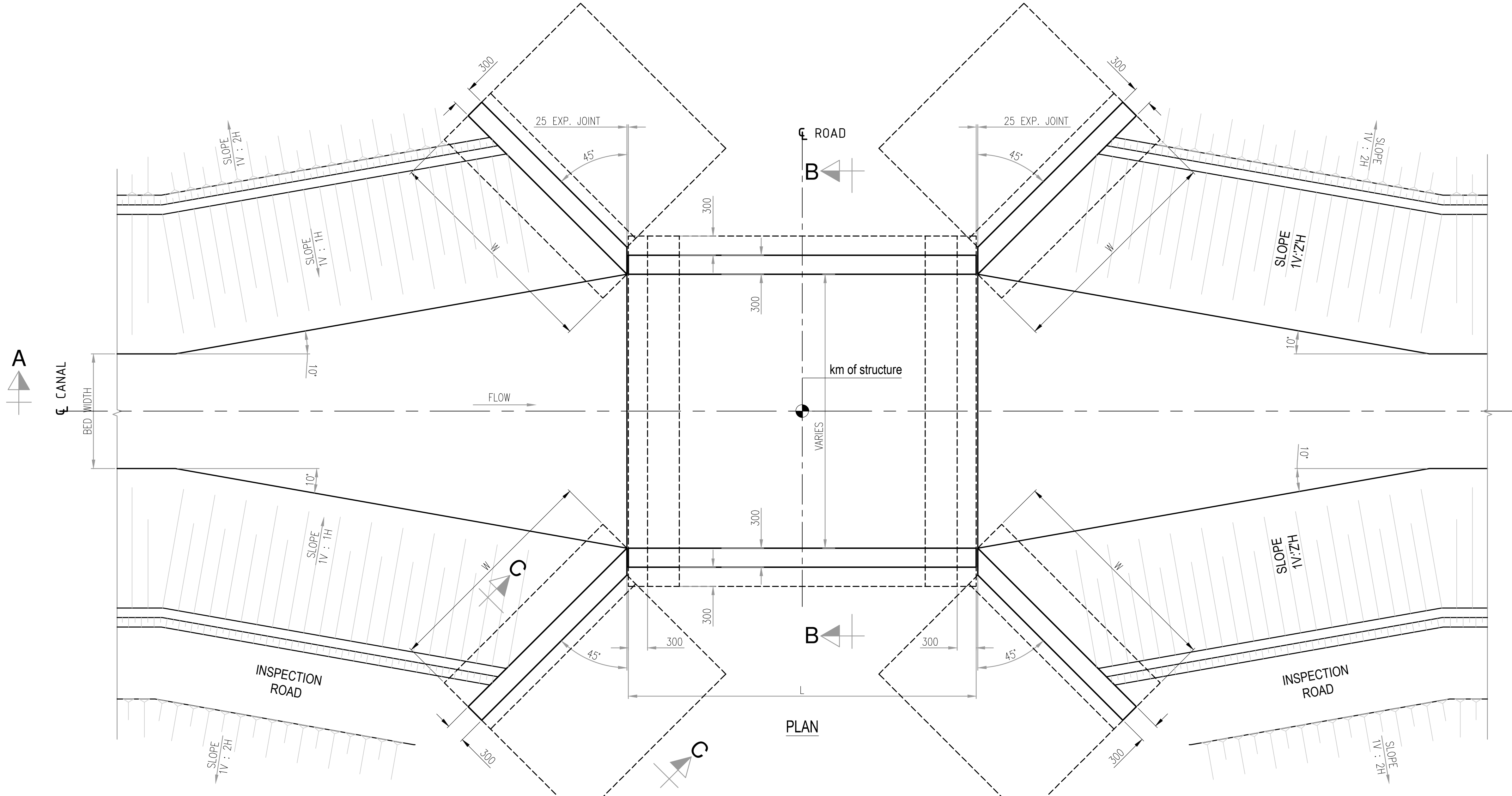
SCALE :- B
0 500 1000 1500 2000
mm

CLIENT :	CONSULTANT:	PROJECT:	DRAWING TITLE :		
ADB ASIAN DEVELOPMENT BANK	Techno-Consult International (Pvt.)Ltd.	BALOCHISTAN WATER RESOURCES DEVELOPMENT PROJECT (TA)	ONE CELL BOX DRAINAGE CULVERT	Designed By : MEHROZ AFTAB	Date : NOVEMBER 2017
		SCHEME: SIRI TOI DAM ZHOB RIVER BASIN		Drawn By : ARSALAN RAFAT	Scale : AS SHOWN
				Checked By : ZAFAR MASOOD SIDDIQUE	Drg No :
				Approved By : DR BASHIR LAKHANI	BWRDP-ZRB-STD-ST-608

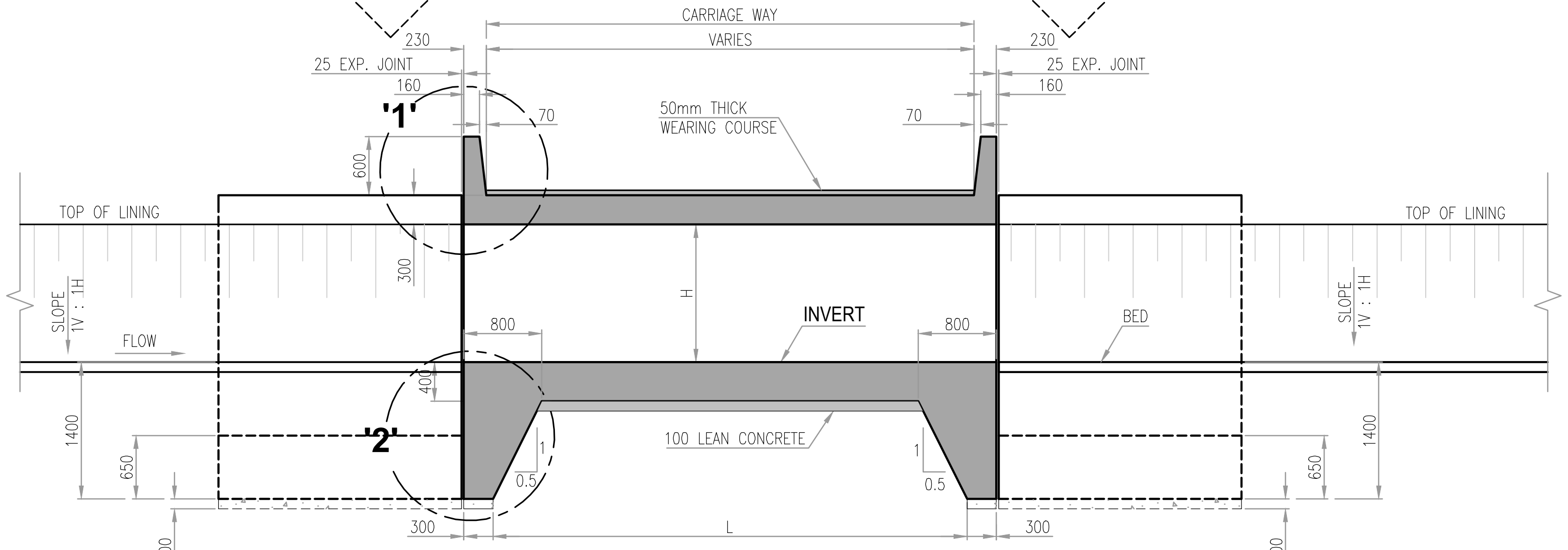
No.	Revision	By	Date

NOTE:

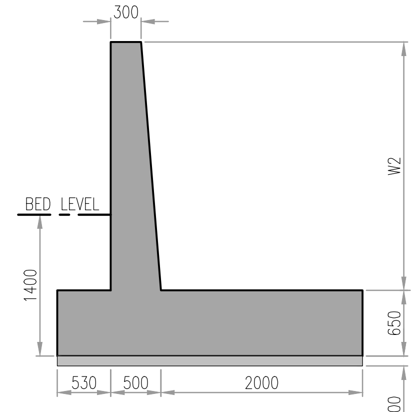
1. ALL DIMENSIONS ARE IN MILLIMETERS.



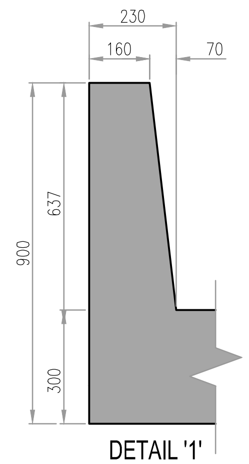
PLAN



SECTION A-A

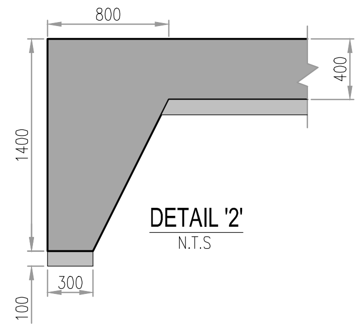


SECTION C-C



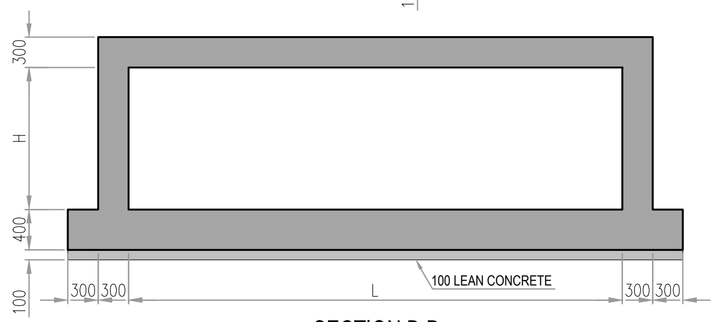
DETAIL '1'

N.T.S



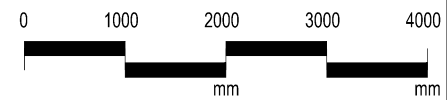
DETAIL '2'

N.T.S



SECTION B-B

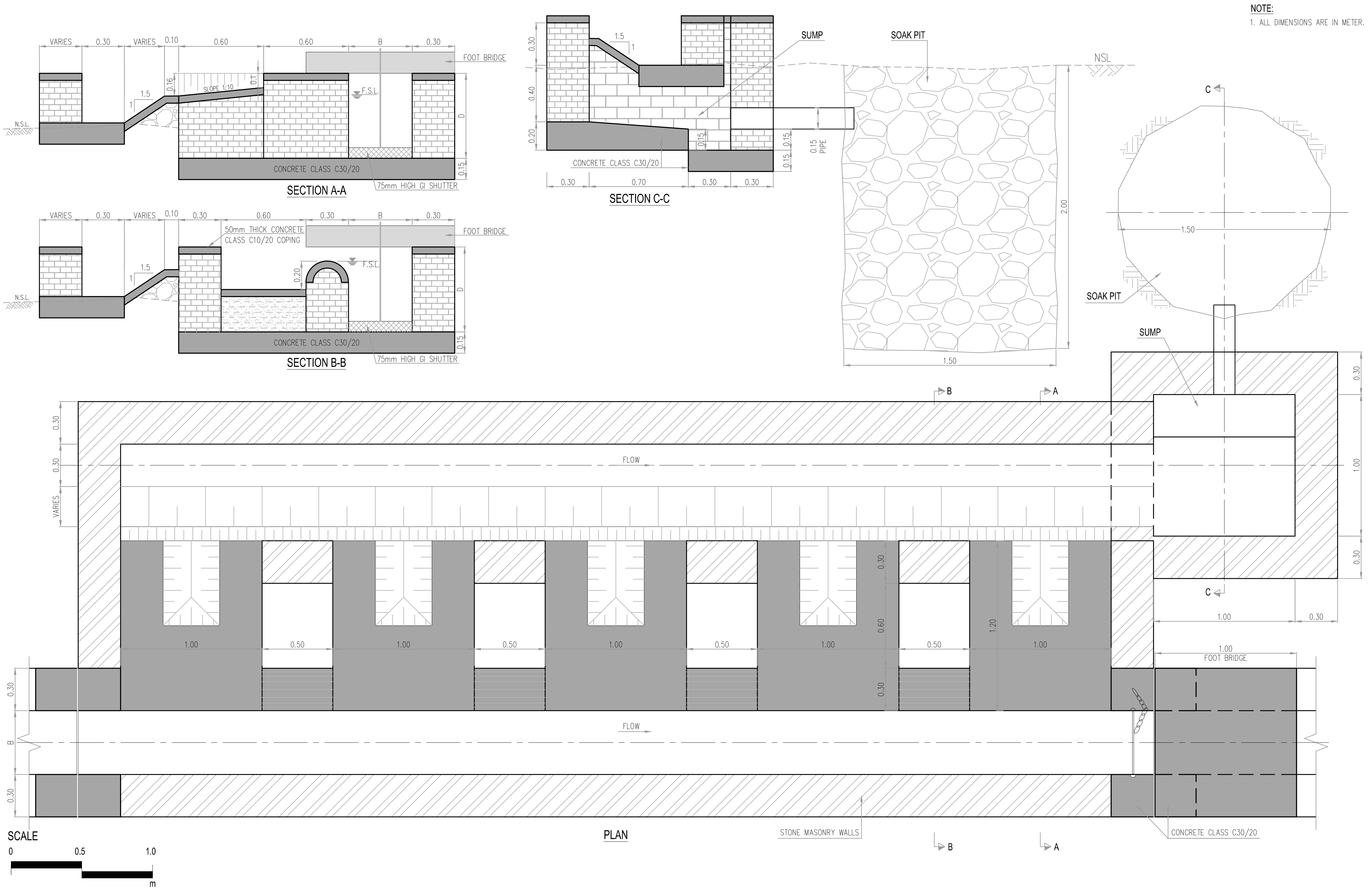
SCALE



LEFT CANAL				
Chainage	W1 (m)	W2 (m)	H (m)	L (m)
4+360	5.0	1.0	1.50	10.0
14+100	4.5	0.5	0.75	10.0

CLIENT :	CONSULTANT:	PROJECT:	DRAWING TITLE :		
ADB ASIAN DEVELOPMENT BANK	Techno-Consult International (Pvt.) Ltd.	BALOCHISTAN WATER RESOURCES DEVELOPMENT PROJECT (TA)	ROAD CULVERT	Designed By : MEHROZ AFTAB	Date : NOVEMBER 2017
		SCHEME: SIRI TOI DAM ZHOB RIVER BASIN		Drawn By : ARSALAN RAFAT	Scale : AS SHOWN
				Checked By : ZAFAR MASOOD SIDDIQUE	Drg No :
				Approved By : DR BASHIR LAKHANI	BWRDP-ZRB-STD-ST-609

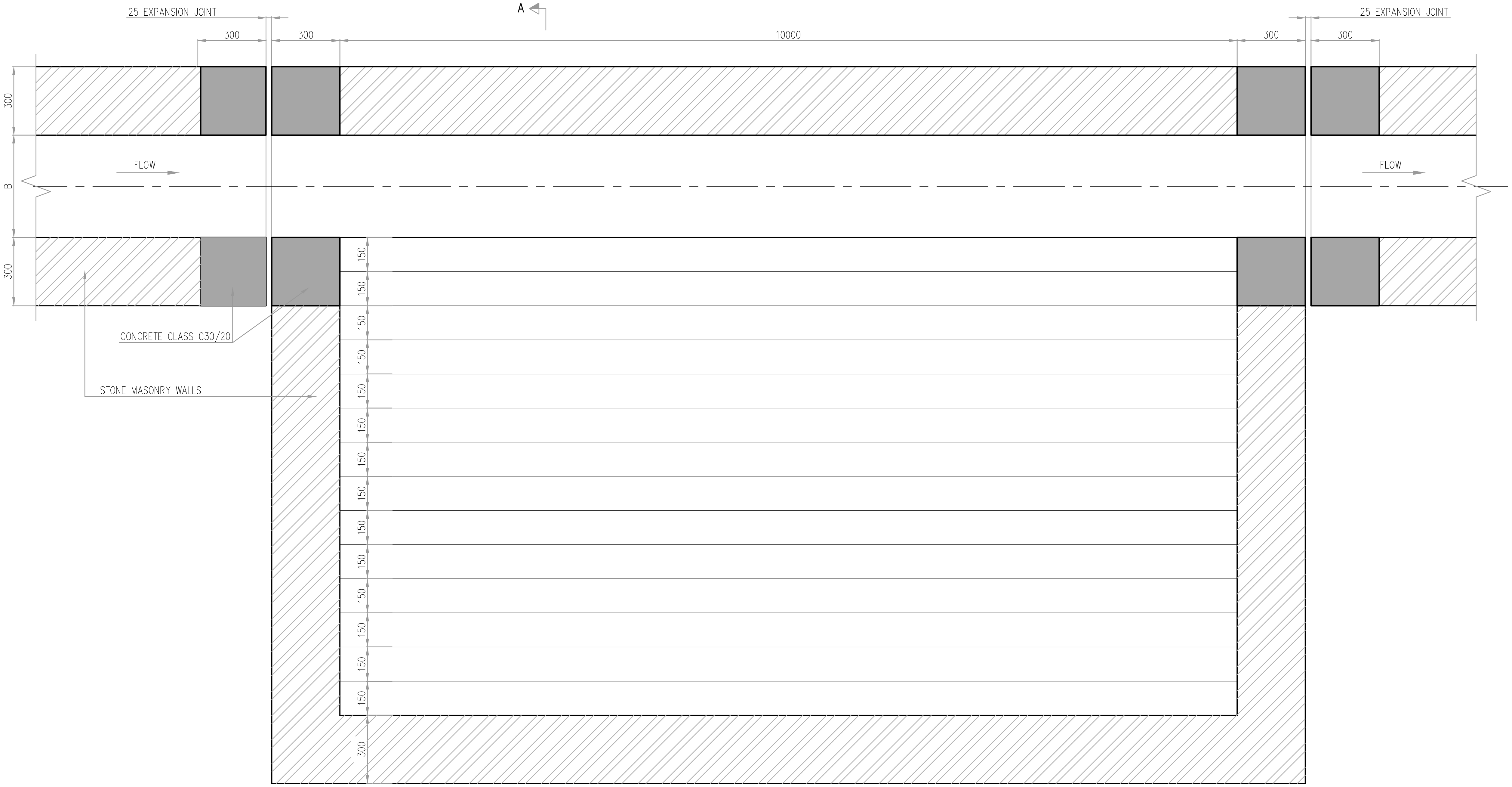
No.	Revision	By	Date



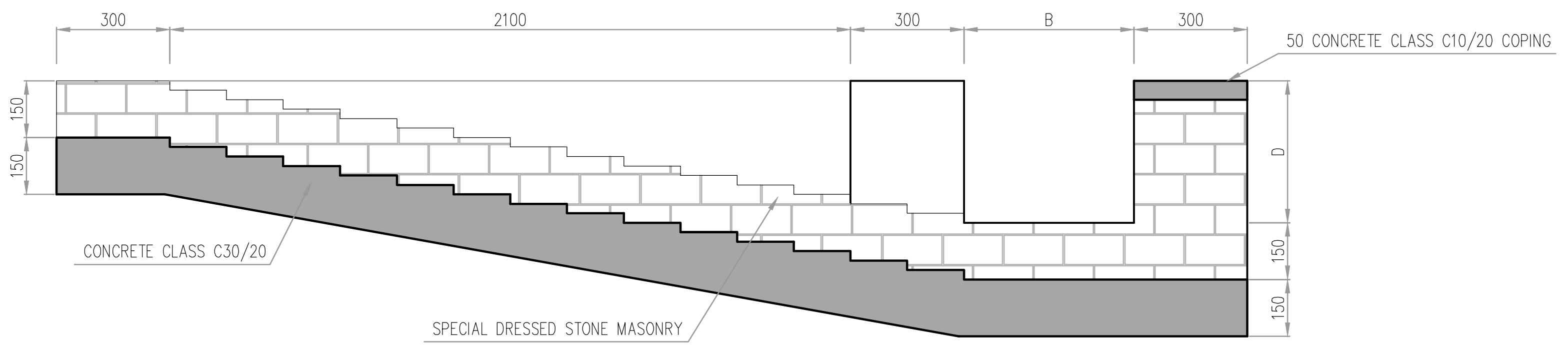
CLIENT: ADB ASIAN DEVELOPMENT BANK	CONSULTANT: Techno-Consult International (Pvt.) Ltd.	PROJECT: BALOCHISTAN WATER RESOURCES DEVELOPMENT PROJECT (TA)	DRAWING TITLE: WASHING STRUCTURE
		SCHEME: SIRI TOI DAM ZHOB RIVER BASIN	

Designed By :	MEHROZ AFTAB	Date :	NOVEMBER 2017
Drawn By :	ARSALAN RAFAT	Scale :	AS SHOWN
Checked By :	ZAFAR MASOOD SIDDIQUE	Drg No :	
Approved By :	DR BASHIR LAKHANI		BWRDP-ZRB-STD-ST-610

No.	Revision	By	Date



PLAN



SECTION A-A

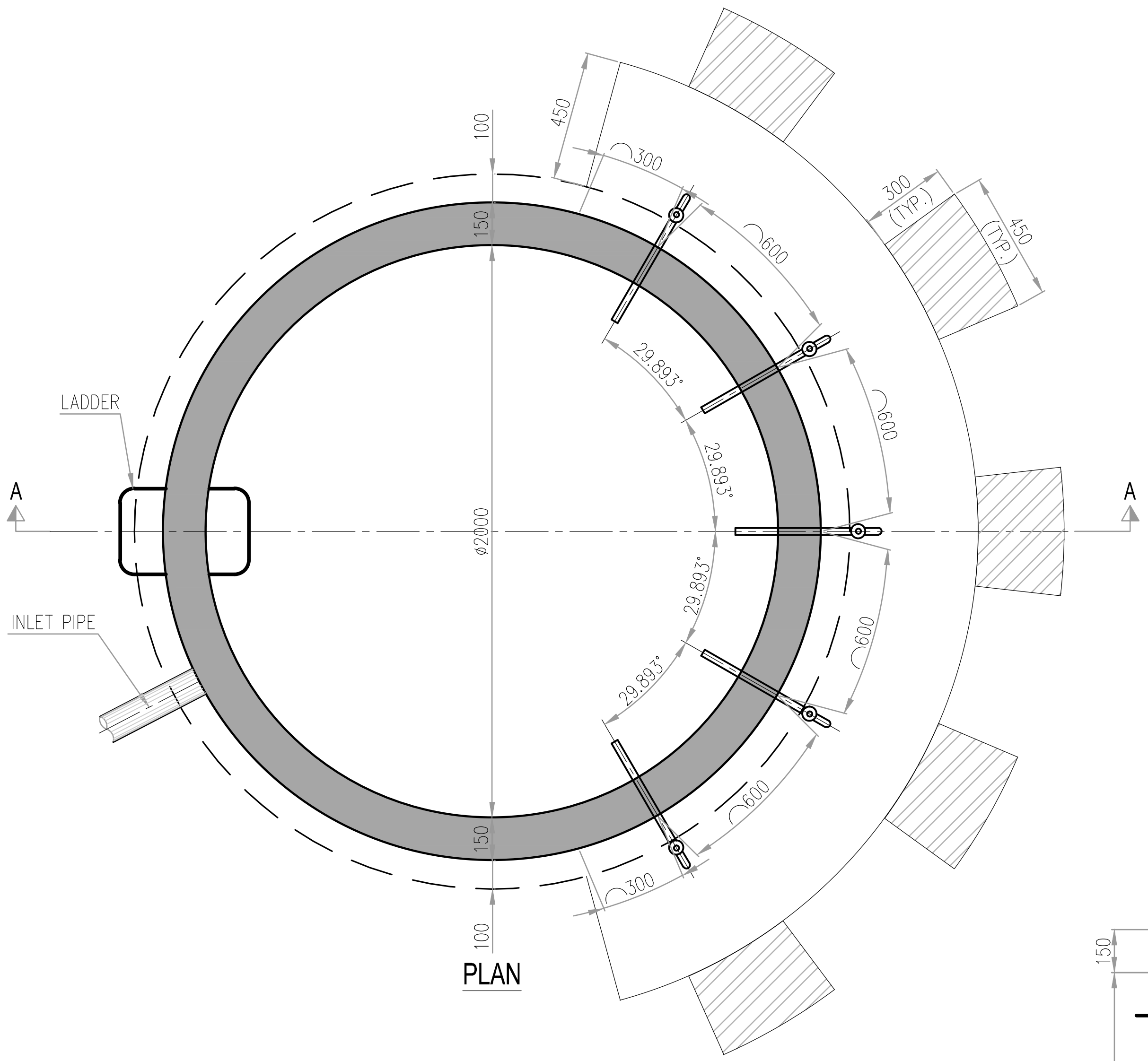
NOTE:
1. ALL DIMENSIONS ARE IN MILLIMETERS & LEVELS ARE IN METER.

SCALE
0 500 1000
mm

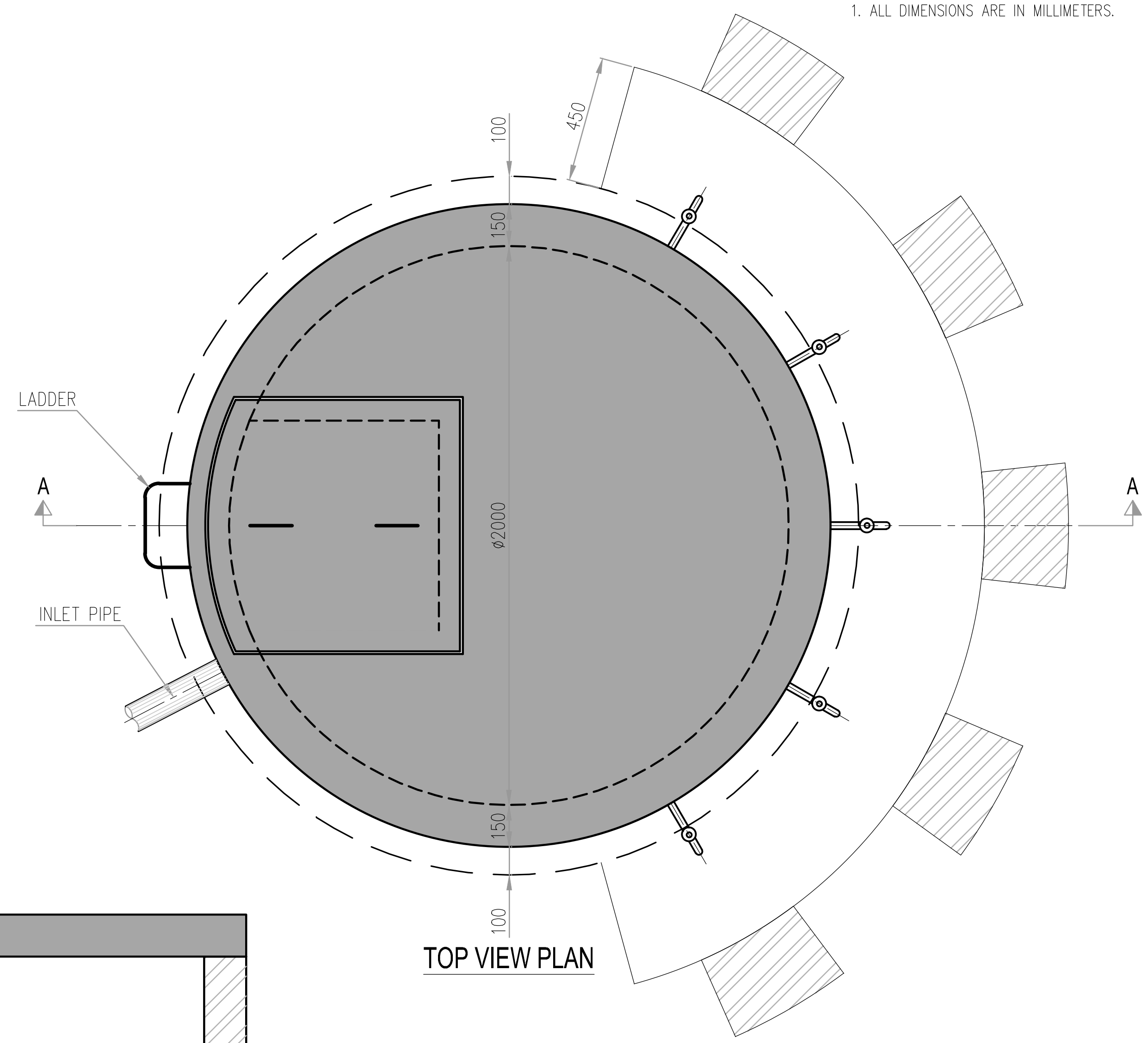
CLIENT : ADB ASIAN DEVELOPMENT BANK	CONSULTANT: Techno-Consult International (Pvt.)Ltd.	PROJECT: BALOCHISTAN WATER RESOURCES DEVELOPMENT PROJECT (TA)	DRAWING TITLE :	Designed By : MEHROZ AFTAB	Date : NOVEMBER 2017
			CATTLE DRINKING TROUGH	Drawn By : ARSALAN RAFAT	Scale : AS SHOWN
		SCHEME: SIRI TOI DAM ZHOB RIVER BASIN		Checked By : ZAFAR MASOOD SIDDIQUE	Drg No :
				Approved By : DR BASHIR LAKHANI	BWRDP-ZRB-STD-ST-611

No.	Revision	By	Date

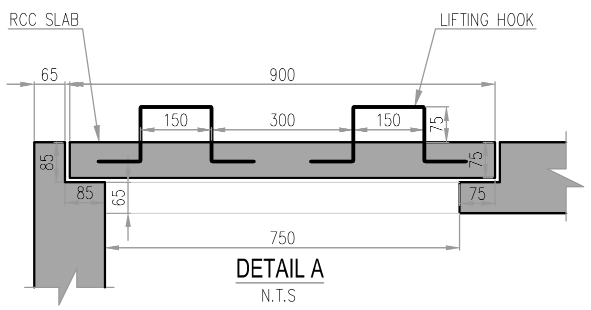
NOTE:
1. ALL DIMENSIONS ARE IN MILLIMETERS.



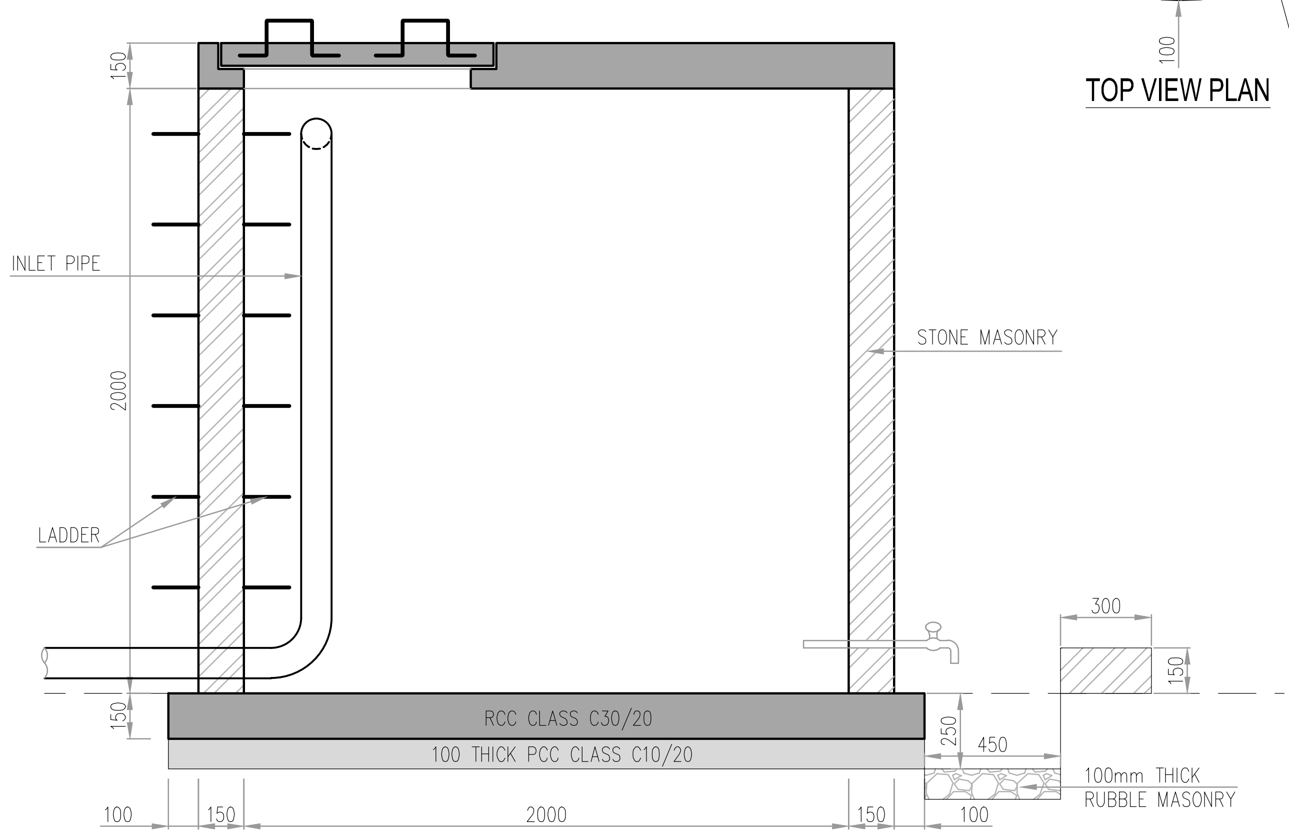
PLAN



TOP VIEW PLAN



DETAIL A
N.T.S



SECTION A-A

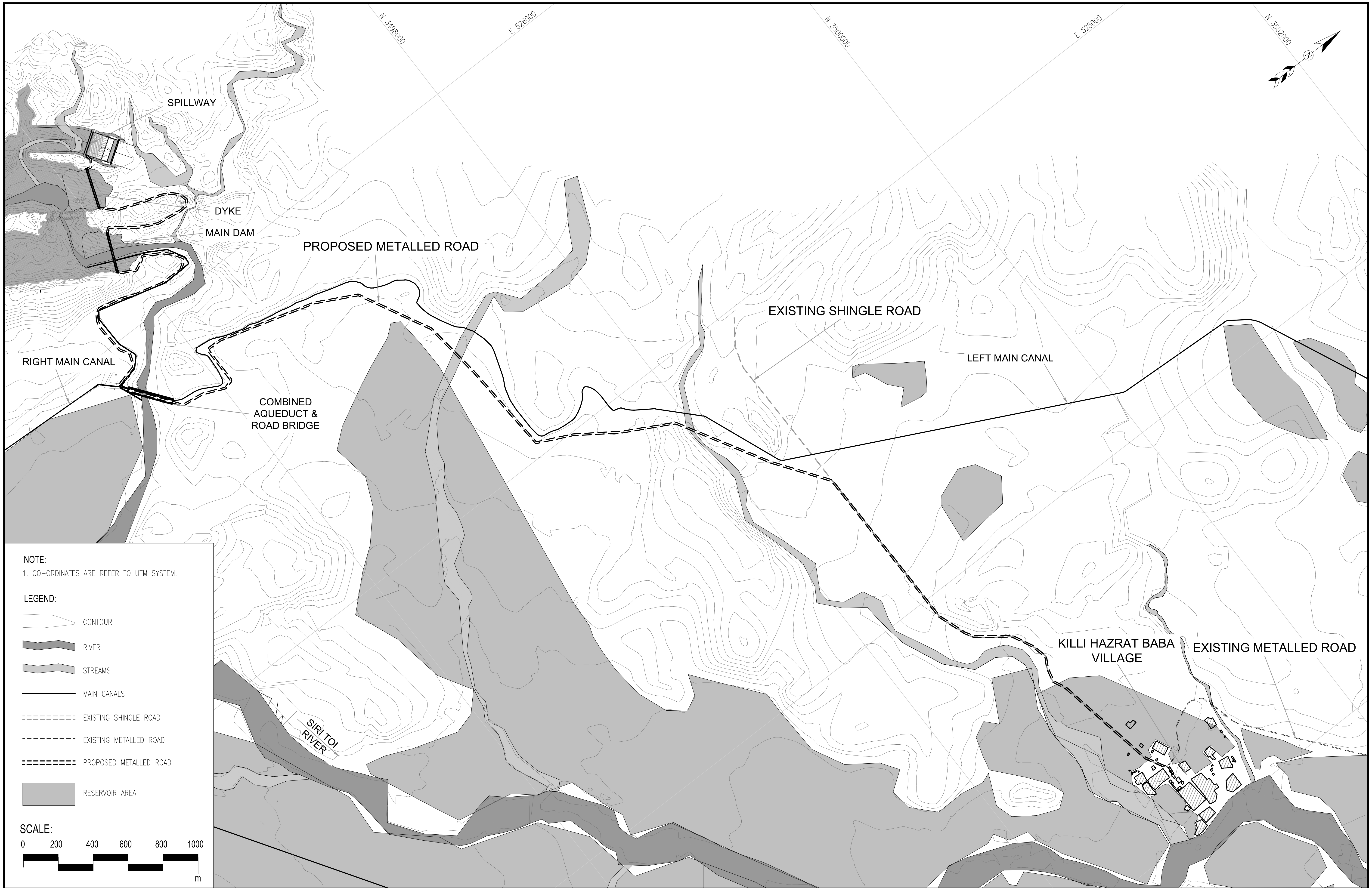
SCALE
0 500 1000
mm

CLIENT : ADB ASIAN DEVELOPMENT BANK	CONSULTANT: Techno-Consult International (Pvt.)Ltd.	PROJECT: BALOCHISTAN WATER RESOURCES DEVELOPMENT PROJECT (TA)	DRAWING TITLE : DRINKING WATER STORAGE TANK	Designed By : SAAD UR REHMAN	Date : NOVEMBER 2017
		SCHEME: SIRI TOI DAM ZHOB RIVER BASIN		Drawn By : ARSALAN RAFAT	Scale : AS SHOWN
				Checked By : ZAFAR MASOOD SIDDIQUE	Drg No : BWRDP-ZRB-STD-ST-612
				Approved By : DR BASHIR LAKHANI	

No.	Revision	By	Date

SIRI TOI DAM

ACCESS ROAD

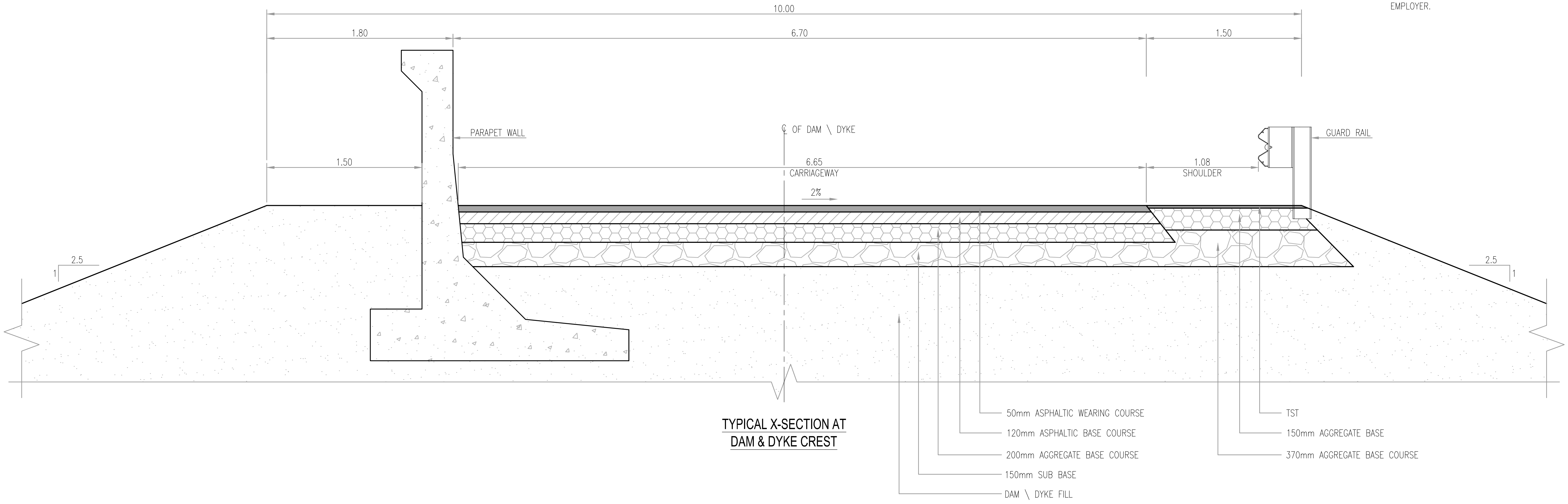


CLIENT :	CONSULTANT :	PROJECT:	DRAWING TITLE :				
ADB ASIAN DEVELOPMENT BANK	Techno-Consult International (Pvt.) Ltd.	BALOCHISTAN WATER RESOURCES DEVELOPMENT PROJECT (TA)	ACCESS ROAD LAYOUT PLAN	Designed By : ABDUL HAI	Date : NOVEMBER 2017		
		SCHEME: SIRI TOI DAM ZHOB RIVER BASIN		Drawn By : ARSALAN RAFAT	Scale : AS SHOWN		
				Checked By : ZAFAR MASOOD SIDDIQUE	Drg No :		
				Approved By : DR BASHIR LAKHANI	BWRDP-ZRB-STD-AR-701		

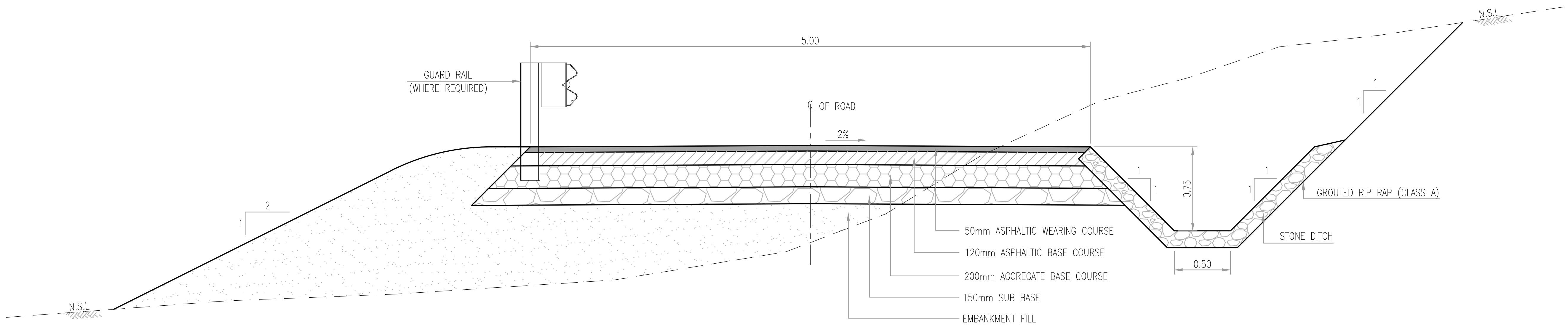
No.	Revision	By	Date

NOTE:

1. ALL DIMENSIONS ARE IN METERS.
2. ANY DAMAGE DONE TO THE UTILITIES DURING EXCAVATION BY THE CONTRACTOR SHALL BE REPAIRED BY HIM AT NO EXTRA COST TO THE EMPLOYER.



TYPICAL X-SECTION AT DAM & DYKE CREST



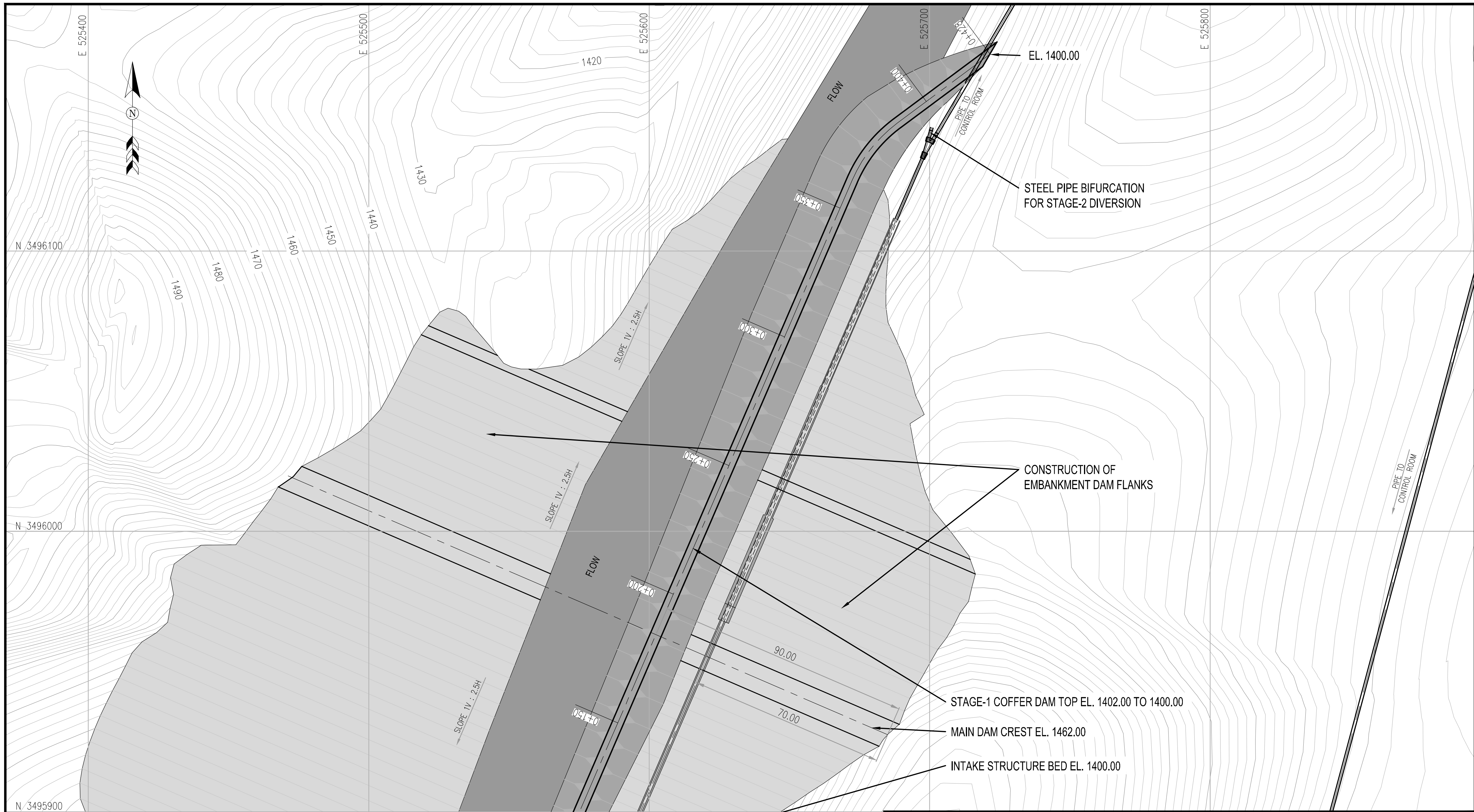
ACCESS ROAD TYPICAL SECTION

SCALE:
0 0.5 1.0 1.5 2.0
m

CLIENT : ADB ASIAN DEVELOPMENT BANK	CONSULTANT: Techno-Consult International (Pvt.)Ltd.	PROJECT: BALOCHISTAN WATER RESOURCES DEVELOPMENT PROJECT (TA)	DRAWING TITLE :	Designed By : ABDUL HAI	Date : NOVEMBER 2017	No.	Revision	By	Date
		SCHEME: SIRI TOI DAM ZHOB RIVER BASIN	ACCESS ROAD TYPICAL CROSS SECTIONS	Drawn By : ARSALAN RAFAT	Scale : AS SHOWN				
				Checked By : ZAFAR MASOOD SIDDIQUE	Drg No :				
				Approved By : DR BASHIR LAKHANI	BWRDP-ZRB-STD-AR-702				

SIRI TOI DAM

RIVER DIVERSION

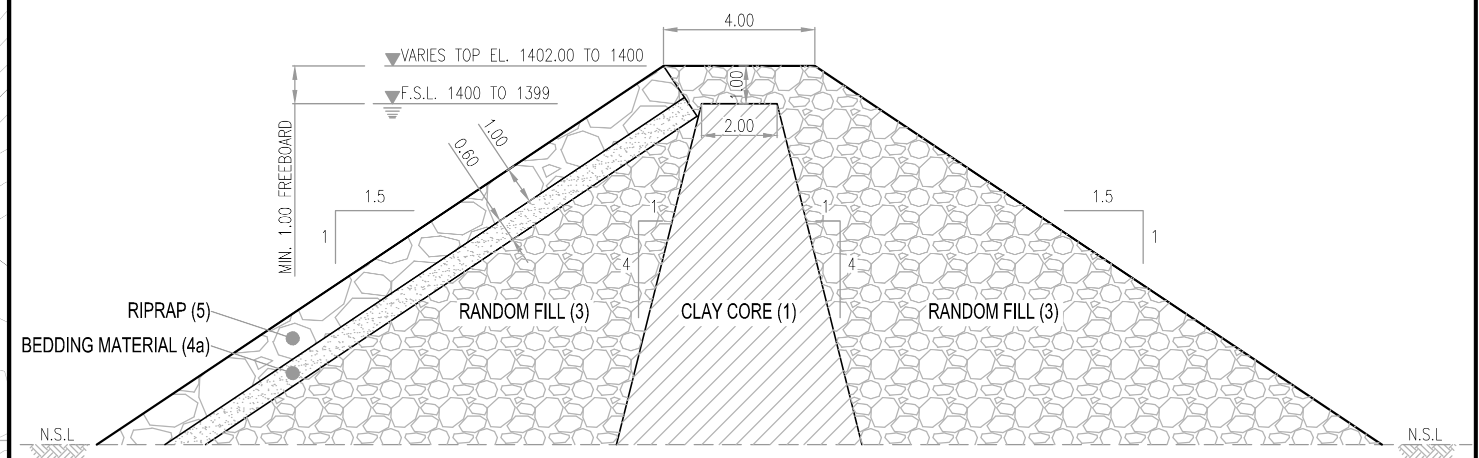


NOTE:

1. ALL DIMENSIONS & LEVELS ARE IN METER.
2. FIRST STAGE RIVER DIVERSION WILL PROCEED WITH CONSTRUCTION OF INTAKE AND APPURTENANT STRUCTURES.
3. COFFER DAM HEIGHT DESIGNED FOR 25-YEAR RETURN PERIOD FLOOD.
4. SECOND STAGE RIVER DIVERSION WILL BE CARRIED OUT DURING LOW FLOW SEASON THROUGH THE COMPLETED INTAKE AND OUTLET STRUCTURE.
5. FOR COFFER DAM FILL MATERIAL REFER TO DWG. NO BWRDP-ZRB-STD-MD-103.

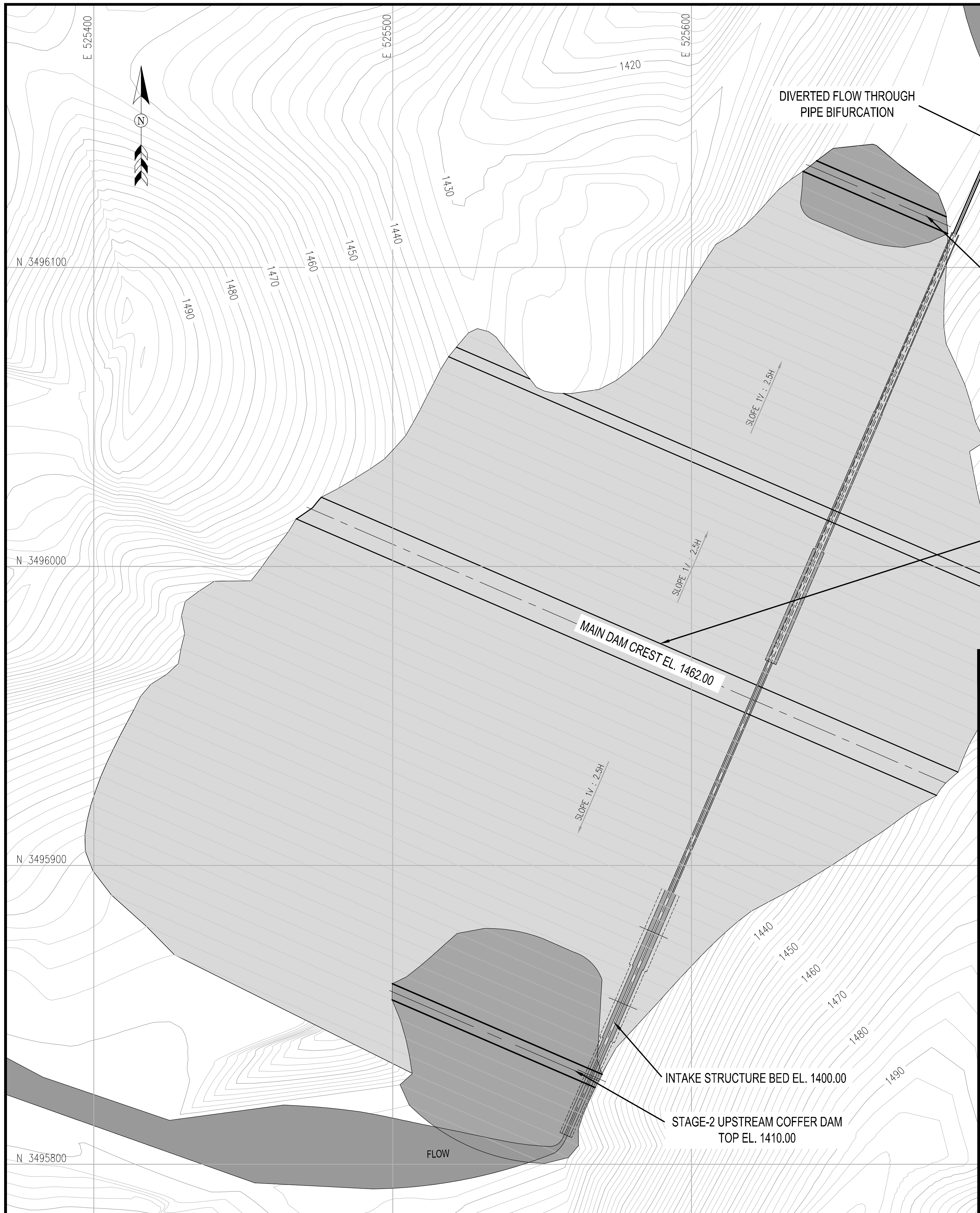
SCALE:
0 25 50 75 m

SCALE:- B
0 2 4 6 8 10 m



TYPICAL CROSS SECTION
SCALE:- B

CLIENT :	CONSULTANT :	PROJECT:	DRAWING TITLE :				
ADB ASIAN DEVELOPMENT BANK	Techno-Consult International (Pvt.)Ltd.	BALOCHISTAN WATER RESOURCES DEVELOPMENT PROJECT (TA)	RIVER DIVERSION STAGE-I COFFER DAM PLAN & SECTION	Designed By : ABDUL HAI	Date : NOVEMBER 2017	No.	Revision
		SCHEME: SIRI TOI DAM ZHOB RIVER BASIN		Drawn By : ARSALAN RAFAT	Scale : AS SHOWN	By	Date
				Checked By : ZAFAR MASOOD SIDDIQUE	Drg No :		
				Approved By : DR BASHIR LAKHANI	BWRDP-ZRB-STD-RD-801		

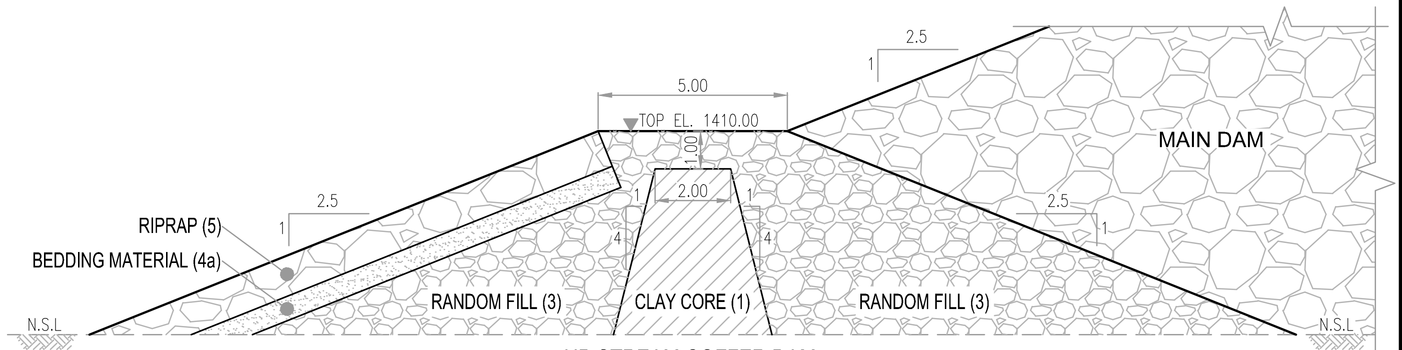


NOTE:

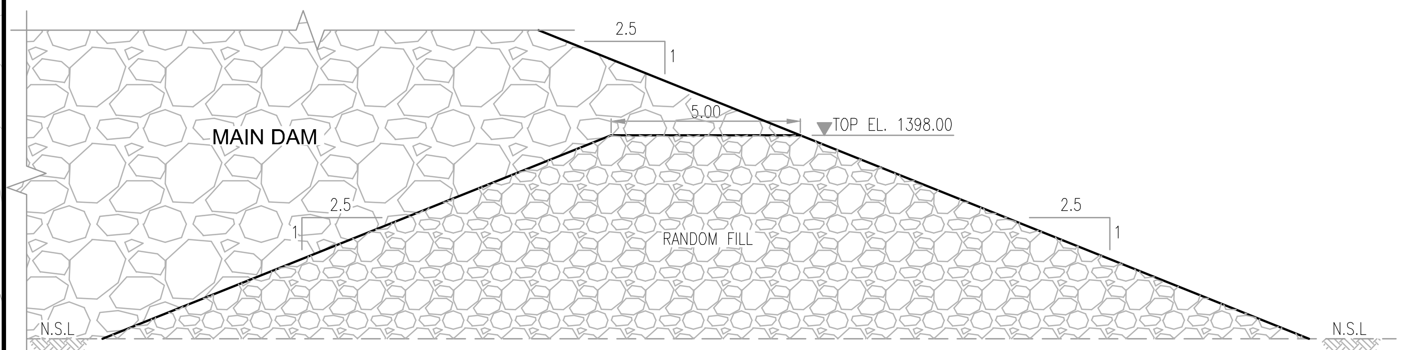
1. ALL DIMENSIONS & LEVELS ARE IN METER.
2. PRIOR TO CONSTRUCTION OF STAGE-II, INTAKE & OUTLET WORKS MUST BE COMPLETED TO FACILITATE LOW FLOW DIVERSION AND TO ASSURE COMPLETION OF REMAINING WORK IN MINIMUM TIME.
3. SECOND STAGE RIVER DIVERSION WILL BE CARRIED OUT DURING LOW FLOW SEASON THROUGH THE COMPLETED INTAKE AND OUTLET STRUCTURE (STAGE-I).
4. FOR COFFER DAM FILL MATERIAL REFER TO DWG. NO BWRDP-ZRB-STD-MD-103.

SCALE:
0 25 50 75
m

SCALE:- B
0 2 4 6 8 10
m



UP STREAM COFFER DAM
TYPICAL CROSS SECTION
SCALE:- B



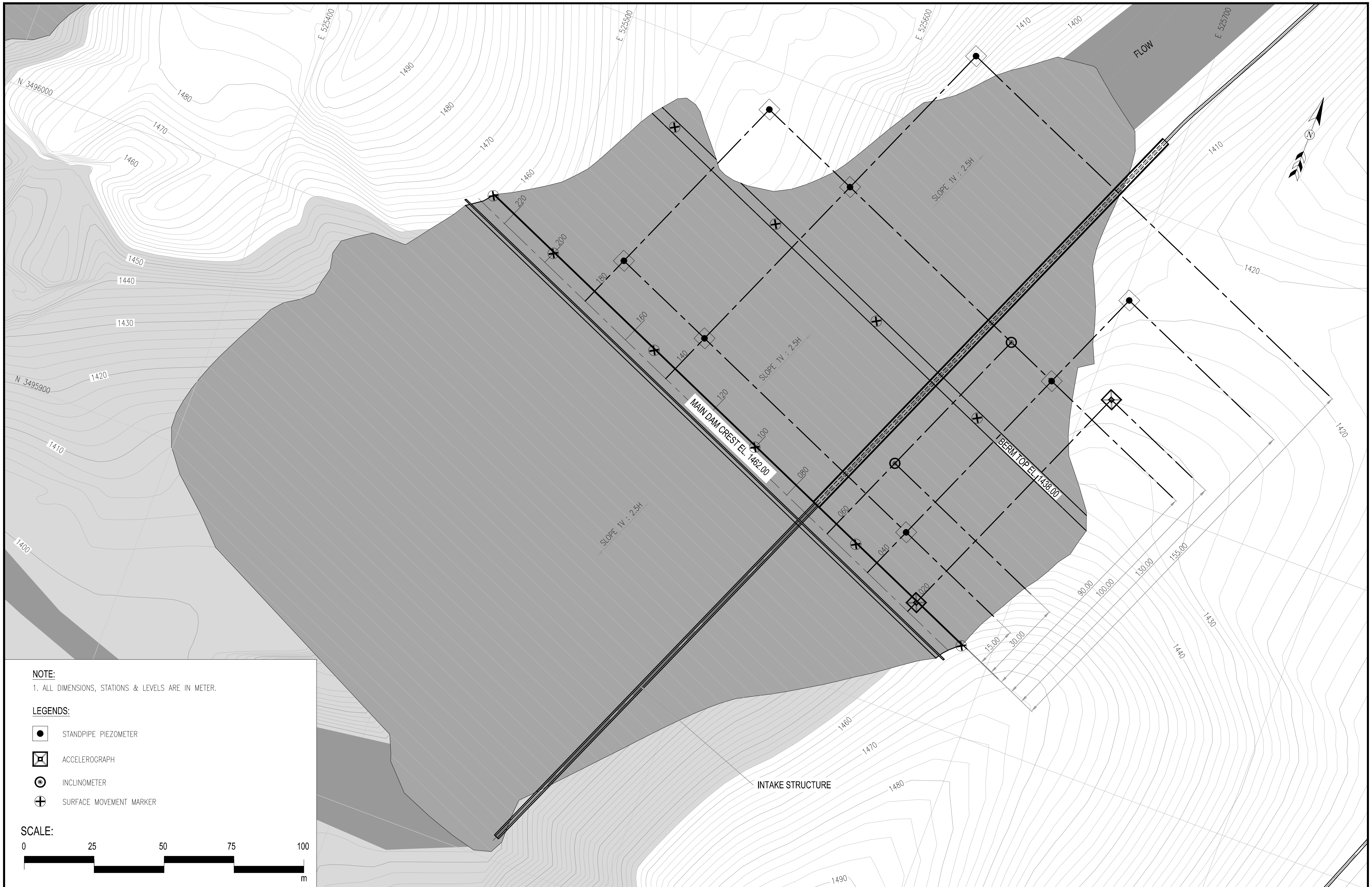
DOWN STREAM COFFER DAM
TYPICAL CROSS SECTION
SCALE:- B

CLIENT : ADB ASIAN DEVELOPMENT BANK	CONSULTANT : Techno-Consult International (Pvt.)Ltd.	PROJECT: BALOCHISTAN WATER RESOURCES DEVELOPMENT PROJECT (TA)	DRAWING TITLE : RIVER DIVERSION STAGE-II COFFER DAM PLAN & SECTION	Designed By : ABDUL HAI	Date : NOVEMBER 2017
		SCHEME: SIRI TOI DAM ZHOB RIVER BASIN		Drawn By : ARSALAN RAFAT	Scale : AS SHOWN
				Checked By : ZAFAR MASOOD SIDDIQUE	Drg No :
				Approved By : DR BASHIR LAKHANI	BWRDP-ZRB-STD-RD-802

No.	Revision	By	Date

SIRI TOI DAM

INSTRUMENTATION



NOTE:

1. ALL DIMENSIONS, STATIONS & LEVELS ARE IN METER.

LEGENDS:

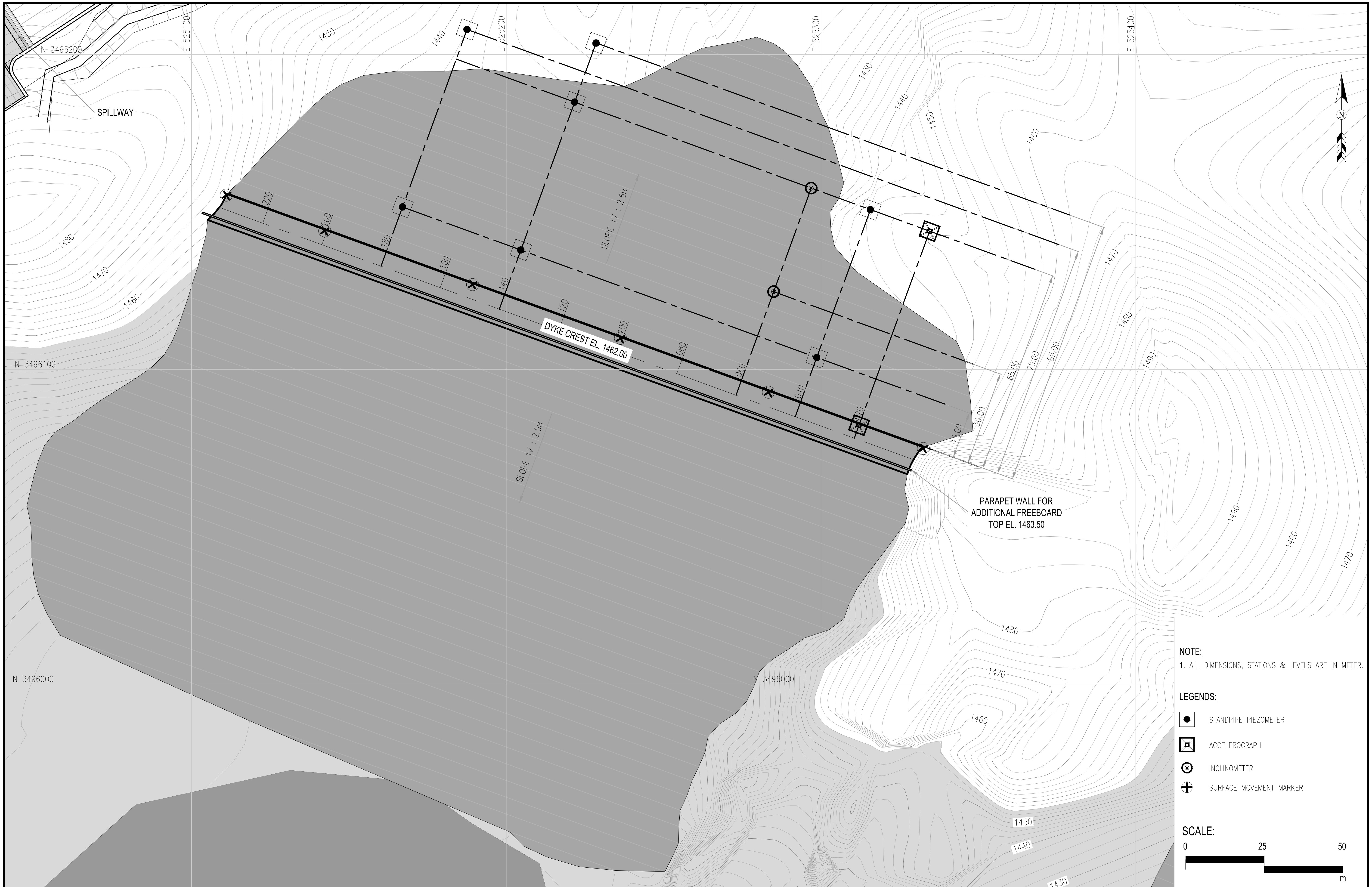
- STANDPIPE PIEZOMETER
- ACCELEROGRAPH
- INCLINOMETER
- SURFACE MOVEMENT MARKER

SCALE:

0 25 50 75 100 m

CLIENT : ADB ASIAN DEVELOPMENT BANK	CONSULTANT : Techno-Consult International (Pvt.) Ltd.	PROJECT: BALOCHISTAN WATER RESOURCES DEVELOPMENT PROJECT (TA) SCHEME: SIRI TOI DAM ZHOB RIVER BASIN	DRAWING TITLE : INSTRUMENTATION ARRANGEMENT PLAN OF MAIN DAM	Designed By : ARIF SAMOON Drawn By : ARSALAN RAFAT Checked By : ZAFAR MASOOD SIDDIQUE Approved By : DR BASHIR LAKHANI	Date : NOVEMBER 2017 Scale : AS SHOWN Drg No : BWRDP-ZRB-STD-INS-901

No.	Revision	By	Date



NOTE:

1. ALL DIMENSIONS, STATIONS & LEVELS ARE IN METER.

LEGENDS:

- STANDPIPE PIEZOMETER
- ACCELEROGRAPH
- INCLINOMETER
- SURFACE MOVEMENT MARKER

SCALE:

0 25 50 m

CLIENT :	CONSULTANT :	PROJECT:	DRAWING TITLE :			No.	Revision	By	Date
ADB ASIAN DEVELOPMENT BANK	Techno-Consult International (Pvt.)Ltd.	BALOCHISTAN WATER RESOURCES DEVELOPMENT PROJECT (TA)	INSTRUMENTATION ARRANGEMENT PLAN OF DYKE	Designed By : ARIF SAMOON	Date : NOVEMBER 2017				
		SCHEME:		Drawn By : ARSALAN RAFAT	Scale : AS SHOWN				
		SIRI TOI DAM ZHOB RIVER BASIN		Checked By : ZAFAR MASOOD SIDDIQUE	Drg No :				
				Approved By : DR BASHIR LAKHANI	BWRDP-ZRB-STD-INS-911				