Environmental Impact Assessment

July 2017

PAK: Jalalpur Irrigation Project

Project No. 46528-002

Part 5 of 9 of the Main Report

Prepared by Irrigation Department, Government of Punjab for the Asian Development Bank (ADB).

Irrigation Department
Government of Punjab

DETAILED DESIGN OF JALALPUR IRRIGATION PROJECT

ENVIRONMENTAL IMPACT ASSESSMENT (EIA)

MAY 2017

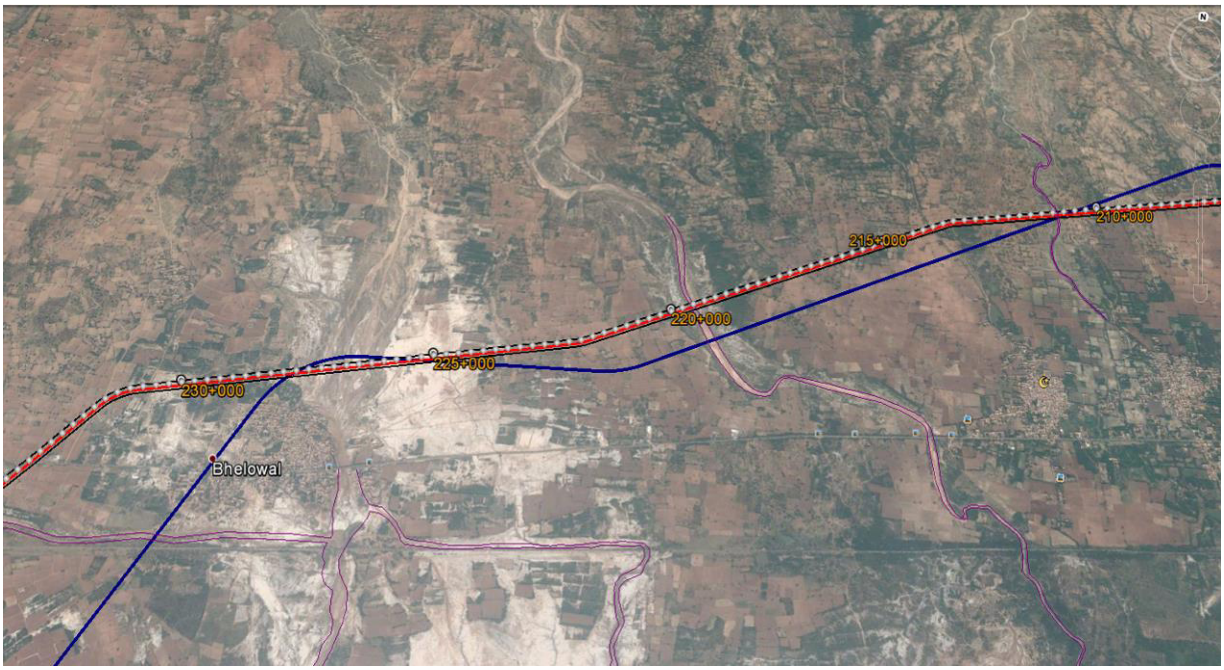


Figure 5.12: Main canal Alignment RD 210+000 to RD 230+000

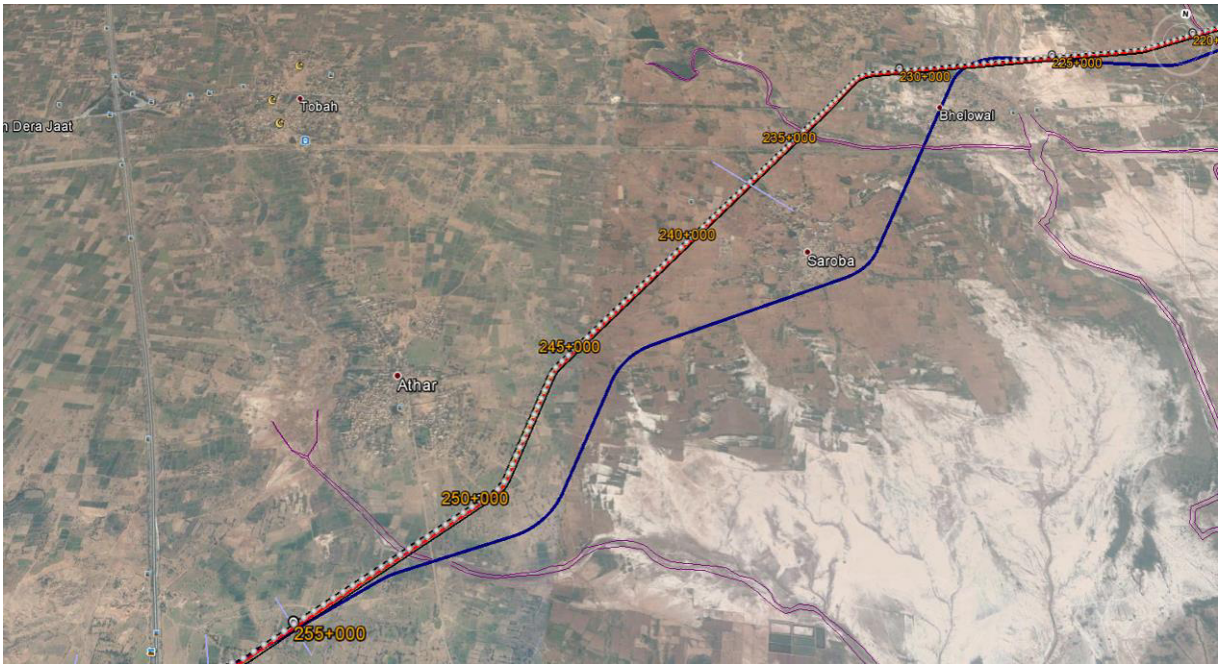


Figure 5.13: Main canal Alignment RD 235+000 to RD 255+000

5.5.10. Reach-7 RD 255+000 to 264+000:

189. There is an already constructed Culvert under motorway at RD 258+150 of the canal. So here alignments of both NESPAK and NDC are similar. **Figure 5.14** shows the Reach-7 of updated canal alignment.

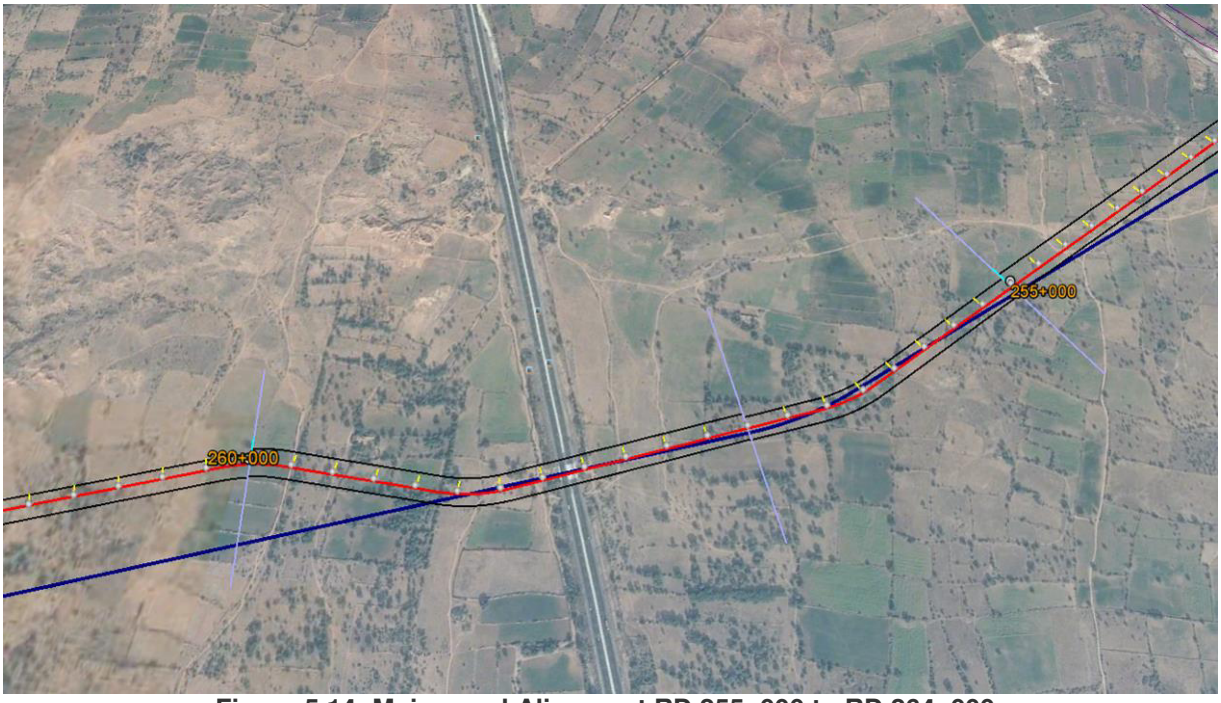
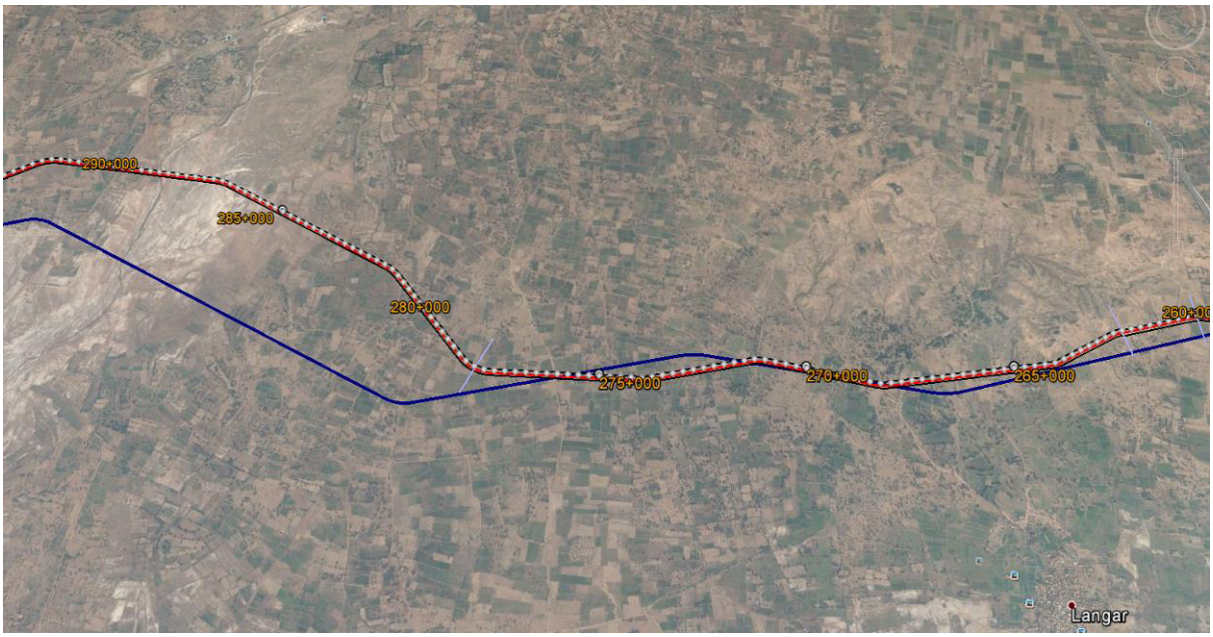


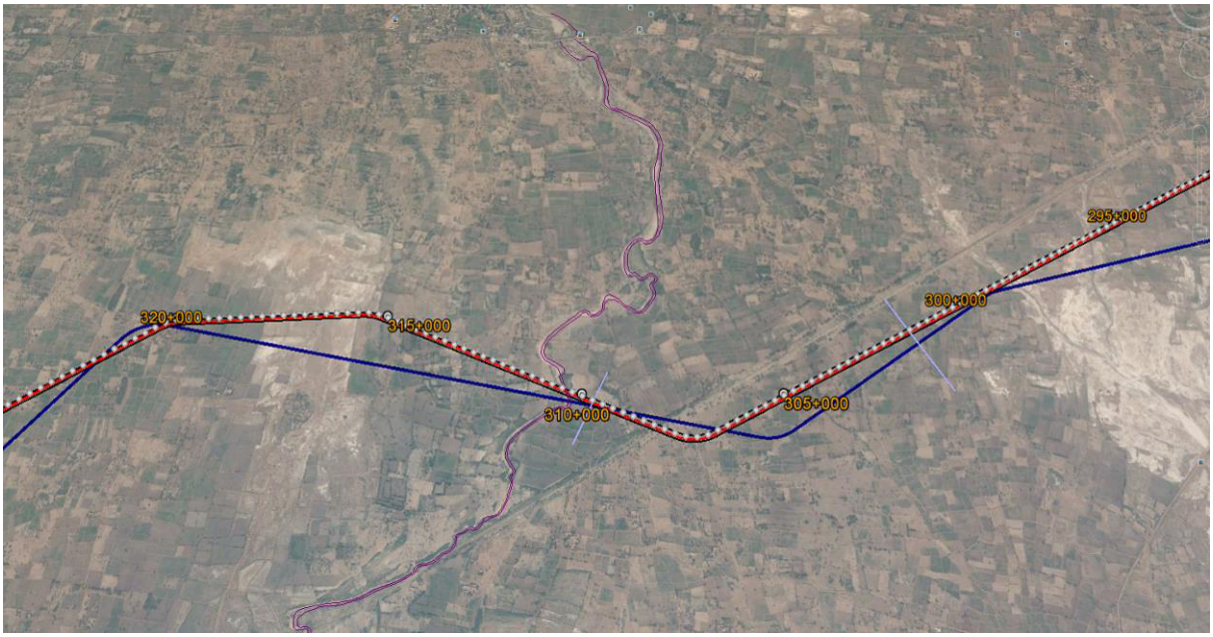
Figure 5.14: Main canal Alignment RD 255+000 to RD 264+000

5.5.11. Reach-8 RD 264+000 to TAIL:

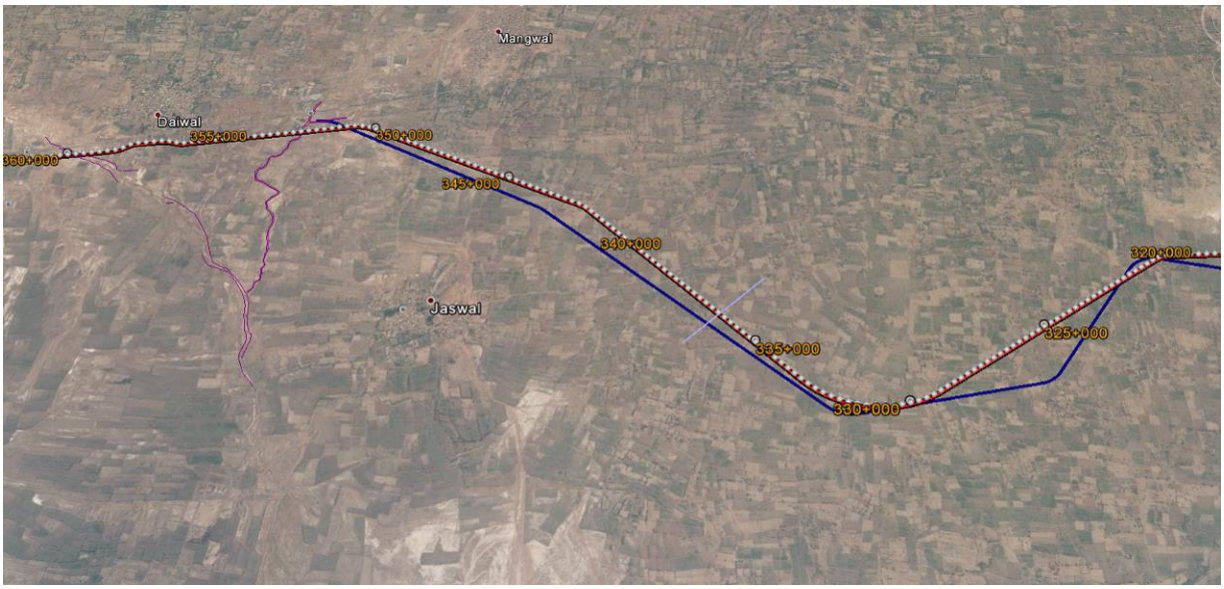
190. In this reach area has been added under the command of the canal. A number of huts and farm houses have also been saved. At RD 329+000 District Khushab starts and 32 RDs of the main canal lies in distruct Khushab. Canal tail is located at Daiwal Village. **Figures 5.15, 5.16 & 5.17** show the segments of Reach-8 till tail of updated canal alignment.



Figures 5.15: Main canal Alignment RD 264+000 to 290+000



Figures 5.16: Main canal Alignment RD 295+000 to 320+000



Figures 5.17: Main canal Alignment RD 320+000 to RD Tail

5.6. Channel Lining Options

191. Two types of channel designs were considered all along the proposed alignment either lined or unlined. It has been assessed that the initial reach of the Main canal upto Jalalpur Sharif (RD 5+000 to RD 33+350) runs through hilly terrain and on the right side are hill slopes and not much space is available therefore, in order to reduce the canal RoW in this reach, a concrete lined section is proposed this would also reduce land acquisition in this part. Furthermore, review of sediment data of Rasul-Qadirabad Link canal shows mainly fine sediment characterized as wash-load (silt and clay) will enter the main canal. Most of the soil strata along canal alignment is composed of fine strata (sandy silt to silty clay) which is even more prone to scour resulting in lowering of canal bed and water levels affecting canal command.

192. It is concluded at detailed design stage that almost negligible sediment will enter the canal system. Thus downstream canal system will be prone to be scour and consequently

O&M cost will be increased. The main canal will run on significant fill (more than 10 ft) from RD 35+000 to RD 75+000 which will be prone to frequent breaches. Lining of the canal will be beneficial as it will safeguard and reduce the potential damage of the reach. Most of the canal reaches would run through area in which groundwater use is hazardous for agriculture production. Unlined canal would promote seepage and rising of water table, which is particularly not suitable for reaches in which saline water table is present.

193. It is expected by design team that due to low silt load and very fine sediment entering the system, the canal may never approach regime conditions.

194. Keeping in view the above situation, lining of the whole canal is recommended. Options available for lining are either concrete-lined or brick-lined canal. As the canal is non-perennial, the canal section will be subject to weathering affect. Concrete lining being tough, durable, relatively impermeable and hydraulically efficient was selected for JIP by consultants at detailed design stage.

5.7. Design Options of Head Regulator at Rasul Barrage

195. For the design of the Head Regulator, two options were available.

- Design as a free flow crest under full discharge condition; and
- Design as an orifice flow. This requires gate with a baffle slab to restrict maximum opening.

196. When designed under free-flow, corresponding to barrage pond the required Head Regulator width is 20 feet (6.09 m) and a 20 ft x 11 ft (6.09 m x 3.35 m) radial gate will be required. Discharge concentration in this case is about 55.7 cusecs/ft, (5.17 cumecs/m), which require a stilling basin about 3 feet (0.91 m) below the downstream bed level of the canal.

197. The regulator may also be designed to flow under orifice (gate-controlled) condition, for the same crest level of 710.4 feet (216.5 m). The optimum bay width is 38.75 ft x 3.75 (11.81 m x 1.14 m). A baffle slab needs to be provided to restrict maximum gate opening.

198. Considering the provision of free flow crest type with radial type gate on Rasul-Qadirabad Link canal on right of Rasul Barrage, the similar arrangement has been provided for Jalalpur canal Head Regulator and is a feasible option out of two.

5.8. Alternate Institutional Models

199. Discussions with PID at various levels indicate that the present institutional setup created under the PIDA Act is also not effective in solving the issues related to equitable water distribution, collection of 'Aabyana' and O&M needs of the irrigation system as envisaged. The following possibilities have been given deliberations:

- Option 1: No Water Users Organizations (WUOs) formed at all and the PID is fully responsible for the O&M of all I&D infrastructure within the command area of the main canal system, including the supply of canal water to all individual farmers;
- Option 2: Only Khal Panchayats (KPs) are formed at watercourse level and PID is responsible for the O&M of the main canal systems, all distributary (and minor) canals and all drainage infrastructure, including the supply of canal water to the head of each watercourse;
- Option 3: Only informal WUOs are formed at distributary canal level to facilitate communication between farmers and PID with regard to the O&M of all I&D infrastructure within the command area of the main canal system undertaken by PID; and

- Option 4: KPs are formed for the O&M of the watercourses and informal WUOs are constituted at distributary canal level to facilitate communication between farmers and PID with regard to the O&M of the main canal system, distributary (and minor) canals and all drainage infrastructures undertaken by PID.

200. In all four alternative models, no FOs will be established and the O&M of the distributary (and minor) canal systems will be the full responsibility of PID and local community will be engaged through KPs. In two of the four alternative models, it is envisaged that the O&M of the watercourses would be the responsibility of the farmers through the formation of KPs. In the last two alternative models, communication between farmers and PID will be facilitated through the formation of informal WUOs at distributary canal level.

201. The main merits and demerits of the aforementioned options for alternative institutional model are summarized below in **Table 5.3**.

Table 5.3: Merits and Demerits of Institutional Models

Option	Merits	Demerits
1	• Only one institution (PID) responsible for O&M of all Irrigation and Drainage (I&D) infrastructure; • PIDA is not needed; and • No elections to be conducted.	• No farmers' involvement in O&M of I&D infrastructure at all; • Supply of canal water to individual farmers is responsibility of PID staff; • No communication between farmers and PID in structured manner; and • Accountability and transparency with regard to O&M may be weak as no WUOs are formed (lack of countervailing power).
2	• Farmers are responsible for O&M of watercourses through KP formation.	• No farmers' involvement in O&M of distributary (and minor) canal systems; and • No communication between farmers and PID in structured manner.
3	• Only one institution (PID) responsible for O&M of all I&D infrastructure; • PIDA is not needed; • No elections to be conducted; and • Communication between farmers and PID in structured manner is facilitated through formation of informal WUOs at distributary canal level.	• No farmers' involvement in O&M of I&D infrastructure at all; and • Supply of canal water to individual farmers is responsibility of PID staff.
4	• Farmers are responsible for O&M of watercourses through KP formation; • Communication between farmers and PID in structured manner is facilitated through formation of informal WUOs at distributary canal level; and • Informal WUOs at distributary canal level will be based on KPs formed at watercourse level.	• No farmers' involvement in O&M of distributary (and minor) canal systems.

CHAPTER – 6

BASELINE CONDITIONS

6.1. Introduction

202. This Chapter provides the description of baseline conditions of JIP AOI. The existing environmental conditions of the proposed project's AOI (500 m corridor) will be used as a benchmark for comparison of before and after construction phases of the project. This baseline will also provide the datum for assessing the impacts and suggesting the mitigation measures, which will be implemented effectively at various phases of the project activities.

6.2. Baseline Study

203. During the previous EIA study carried out at the feasibility stage, the baseline conditions of the physical, biological and socio-economic components of the receiving environment were assessed. At detailed design stage, updated EIA has included the following additional tasks and assessments:

- One more round of instrumental monitoring for surface water, ground water and wastewater sampling, air quality and noise;
- Biodiversity survey in winter season;
- Updating the information of project area from environmental prospective to take stock of any changes since the feasibility study to update baseline conditions;
- Collection of additional updated data on physical, biological and socio-economic environment in project's AOI; and
- Another round of meetings held with various stakeholders in District Jhelum, Mandi Bahauddin and Khushab as detailed in Chapter 7.

204. The following sections present the updated baselines.

6.3. Field Visits and Data Collection

205. The data presented in the forthcoming sections have been collected from the primary and secondary sources. For the primary data acquisition for updated EIA, the EIA team conducted the reconnaissance and detailed field visits. For field observations, EIA team conducted the reconnaissance visit on Sep 27, 2016 followed by detailed field visits in various phases. First phase of field visit was conducted from Dec 14 to Dec 18, 2016 and second phase of the field visit was conducted during Jan 02 to Jan 08, 2016. Subsequently, field visits for instrumental environmental monitoring were also conducted in third and fourth phases. In third phase field work continued for instrumental monitoring from Jan 20 to Jan 24, 2017 and stopped due to heavy rainfall in the project area. Fourth phase field work was started on Feb 07, 2017 to Feb 12, 2017 to complete the work. The major objective of the field visits was to collect the baseline data on physical and biological aspects. Social experts visited the project AOI intermittently in January, February, March and April months of year 2017. The secondary data was collected from published sources/reports and relevant departments, which were also verified through visual observations during reconnaissance surveys and detailed visits.

6.4. Physical Environment

206. This section describes the physical environment of the proposed project AOI, refer **Appendix-I**. The emphasis is given on topography, land use, geology, soil conditions, climate, surface and ground water resources, ambient air and noise quality and seismology.

6.4.1. Topography

207. The initial reach of the proposed main canal from Rasul Barrage to Jalalpur Sharif runs through hilly terrain after which the canal shifts slightly away from the hill toe. On the right side is hill slope and on the left side is the Jhelum River. Numerous hill torrents cross the main canal at various locations. From Bhelowal to Daiwal, the proposed canal runs through plain land and at some locations it crosses through depressed and raised sections of land, where cut and fill will be required during construction. The command area is mostly plain and underlain by highly brackish to marginally usable groundwater. **Figure 6.1** below shows the topography of the project area.

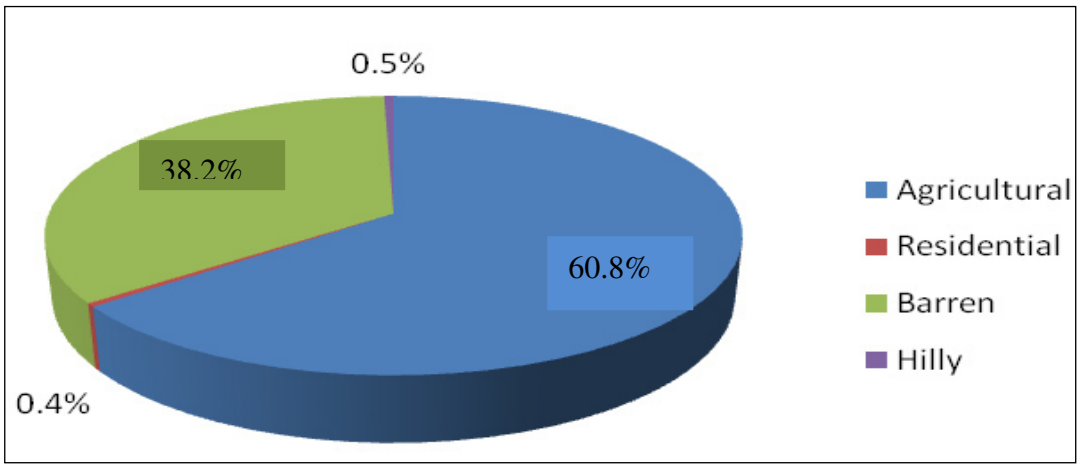
Figure 6.1: Topography of the project area

6.4.2. Land-Use

208. Dry-farmed agriculture is the main land use in the major part of the area. A narrow strip of the area along the Jhelum River (Jalalpur to Haranpur) is irrigated by wells and tube wells. Torrent water is used for cultivation practices in the mountains base and further down the piedmont slope along torrent beds in the east, is another important land use i.e. uncultivated area. Uncultivated area is under shrubs and forests. Scanty vegetation on the sandy, badly dissected and part of the mountainous areas provides poor grazing. **Figure 6.2** below shows the existing landuse of the project area.

Figure 6.2: Existing Landuse of project area

209. Project area comprises various land use categories, i.e. 60.82% agricultural, 38.2% barren and 0.96% others (residential, hilly). Graphic illustration is given in **Figure 6.3**.



Source: Social Expert, Detailed Design Stage

Figure 6.3: Landuse Category

210. Upstream at the Rasul Barrage these exist a patch of dense canopy which gradually dilute into almost an open field with grass covered and Game Reserve, which consists of extensive reed beds and an abundant growth of submerged and floating aquatic vegetation. It is bounded on the south side by the Jhelum River which runs along it almost throughout its length and on the north side by a range of hillocks.

6.4.3. Geology

211. The project area crosses over four types of surficial characteristics. In the beginning the alignment passes through the Potwarfluvio where diversified nature of soil is encountered. Abrased rock fragments intermixed with sand and clay are abundant in the piedmont plains of the Potwar and Salt ranges. The alluvium deposits of hill torrents which are widespread along the hill torrents, have their own independent characteristics and texture. The flood plains of the Jhelum River consist of silty sand and silty clay alluviums which are best suited for agricultural purposes.

212. The salt range mountains are barren, but rich in minerals, containing Coal, Gypsum, and are one of the richest salt fields in the world. Layers of bituminous shale, dolomite, and bauxite are found. Large deposits of high-grade gypsum and anhydride also occur.

213. There are three small scale local faults present in the area. The faults are Reverse Fault near to the Khewra, Normal Fault near Khewra in which hanging wall has been moved down of relative to foot wall and Grungal Thrust Fault near Choa Saidan Shah City.

6.4.4. Soils

214. Soils of the area have variable characteristics in terms of surface salinity, derived land capability and crop suitability. A brief on each characteristics is given below:

Surface Salinity:

215. It is observed that 35.25 % area is non-saline, 20.5 % slightly saline, 8.01% moderately saline and 32.77% strongly saline. The remaining 3.47% is miscellaneous area. The analysis carried by the Consultants indicate that the areal extent of the surface salinity mapped by the various agencies varies in chronological terms.

216. In 1962-63, total saline area was 66 %, which got decreased to about 50 or 51 % in 1975 to 1977 during salinity surveys by Soil Survey of Pakistan (SSOP) and WAPDA. It means about 15 to 16 % area was improved after about 13 to 15 years period. Afterward about 10 % of total saline area again got increased or deteriorated to 61 % after 37 years. However, overall 15 % of slightly saline and 6 % of moderately saline soils area have been improved in last 53 years.

217. The above analysis indicates that extent of surface salinity varies due to that fact that whenever the saltish water carried by the hill torrents spread over the area, the salinity extent increases. Otherwise, the land is arable and this fact has been confirmed by design teams that extent and level of surface salinity is not permanent. Once proper disposal of saline water debouching from the salt range hill torrents is ensured, the lands would be good for agriculture.

***Land Capability*:**
218. Land capability classification is an interpretation of the soil data collected through field surveys and laboratory investigations of the project area. The classification is based on the nature and magnitude of soil limitations affecting the crop production of the soils.

219. The analysis shows that 89.2 % i.e. 67,983 ha of project area consist of class-I (very good agricultural land) and class- II (good agricultural land) lands under the ultimate development conditions while 6.92 % (5,270 ha) is the class III (moderate agricultural land) lands. Collectively these lands are 96.12 % of the project area, which is a good sign for the development of the area. The aerial distribution of these land capability classes is shown on **Figure 6.4**.

***Crop Suitability*:**
220. Crop suitability ratings of the soils are the assessment of their relative suitability for sustained production of specified crops. These are based on two factors, soil characteristics and climate of the area, and range from Class I, for the most suitable to Class 4, for the least or not suitable soils.

221. Soils rated according to “Potential” conditions on the basis of field observations and interview of farmers, revealed that about 89% of the project area comprises well to moderately suited soils for most of the crops proposed to be grown in the area under “Potential Conditions”. About seven % is moderately to marginally suited because of somewhat sandy nature. However, it is presently used for agriculture. The remaining area is not suitable for agricultural crops because of miscellaneous land type

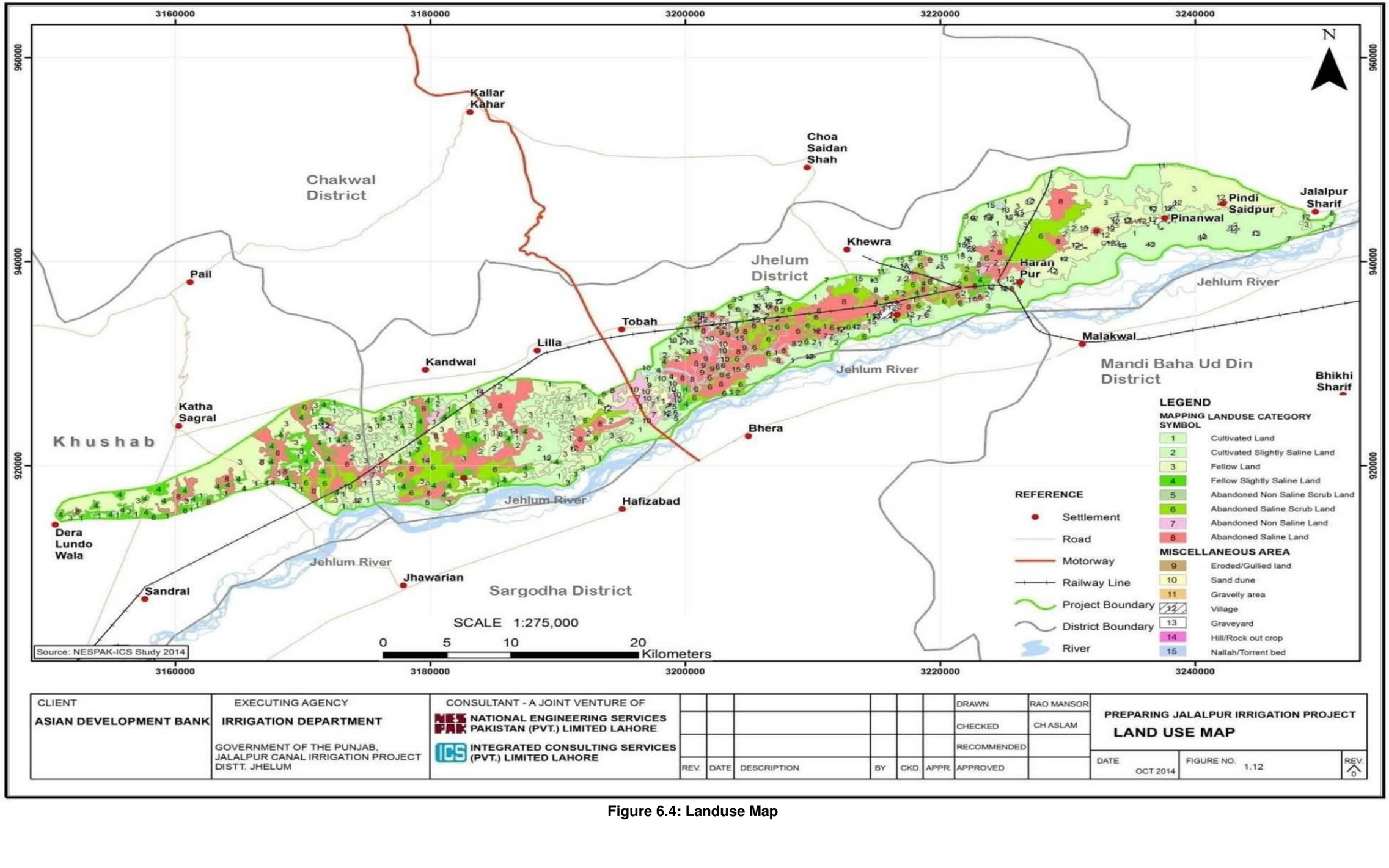


Figure 6.4: Landuse Map

6.4.5. Seismology

222. Earthquake is generated by tectonic process in the upper part of the earth called lithosphere, which is divided into several rigid parts called “Plates”. Due to the movements of these plates, stress build up takes place and result in the deformation of the crustal mass.

223. On the basis of Peak Ground Acceleration (PGA) values obtained through Probabilistic Seismic Hazard Assessment, Pakistan is divided into 5 seismic zones in line with the Uniform Building Code (UBC) 1997. The boundaries of these zones are defined on the basis as shown in **Table 6.1**.

Table 6.1: PGA Values of Seismic Zones of Pakistan

Zone	PGA (g)
1	0.05 to 0.08
2A	0.08 to 0.16
2B	0.16 to 0.24
3	0.24 to 0.32
4	> 0.32

Source: Building Code of Pakistan Seismic Provisions, 2007

224. The proposed JIP as per Building Code of Pakistan, 2007 (Seismic Provisions) falls into the zone 2B which is the regions of moderate seismic risk (**Figure 6.5**)**.** Hence all the applicable provisions, related to soil and foundations, structural design requirements has been considered in the design of the structures[1].

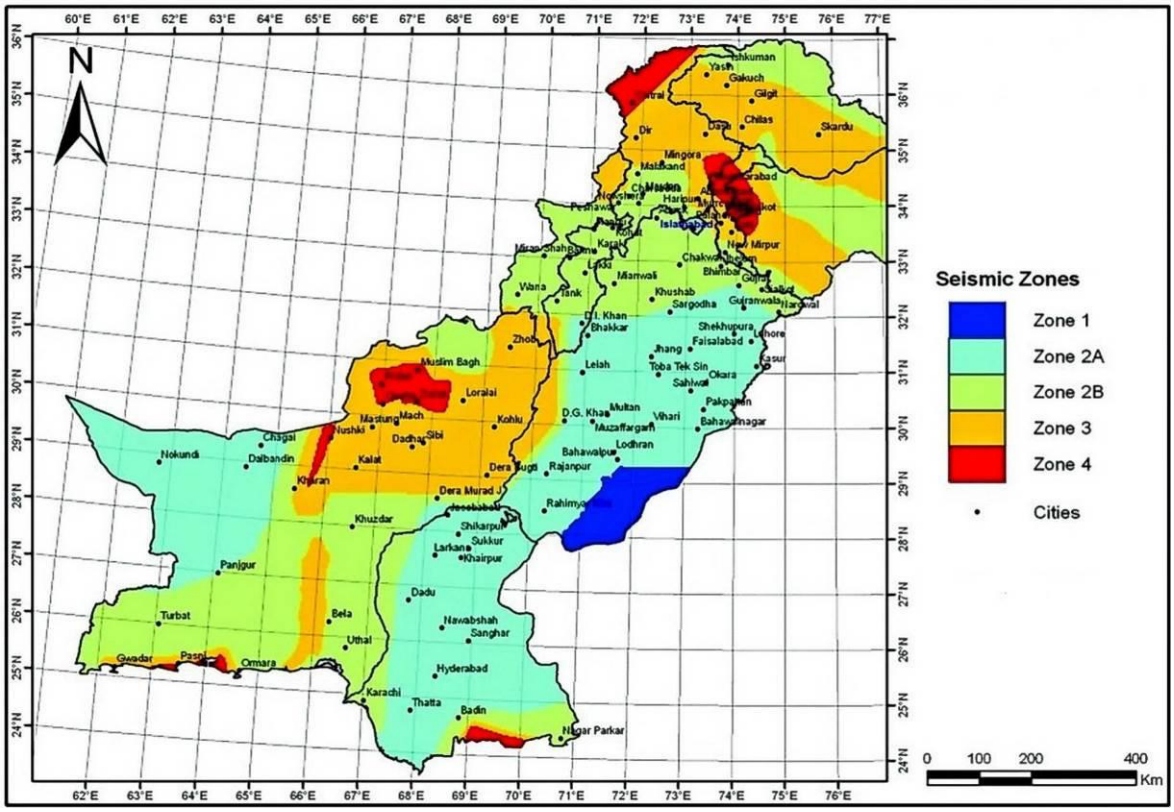


Figure 6.5: Seismic Zoning Map of Pakistan

[1] Building Code of Pakistan (Seismic Provisions – 2007), Ministry of Housing and Works

6.4.6. Climate

225. The climate in the project area is hot and arid.

a) Temperature

226. The nearest weather station of Pakistan Meteorology Department (PMD) to record the temperature in project area is Jhelum. The daily maximum and minimum data from years 1980 to 2013 was collected to determine the variability in the temperature. The results indicated that mean temperature over the period of 34 years is 30.68°C, whereas maximum temperature was recorded in year 2003 with a value of 33.07°C. The average minimum temperature recorded over the same period is 16.77°C with minimum temperature of 11.74°C that was recorded in year 2003. **Figure 6.6** shows maximum and minimum annual temperature from 1980 to 2013.

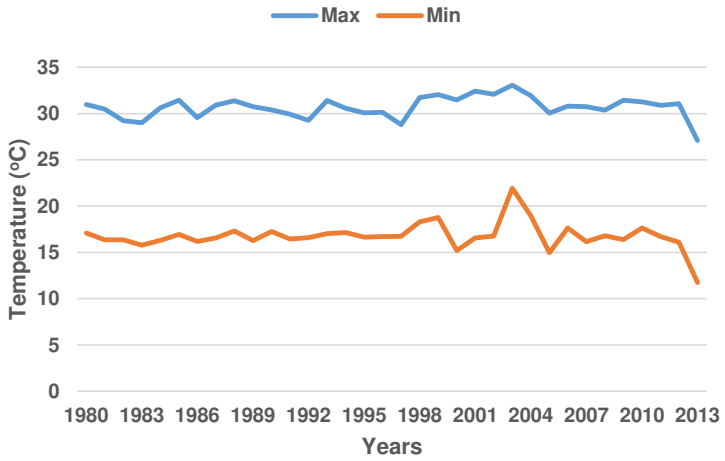


Figure 6.6: Historic Maximum and Minimum Temperature for the Jhelum

227. The average values for historic temperatures for Jhelum station (continuous data) for the period of 1980 to 2013, were calculated as shown below in **Figures 6.7 and 6.8** .

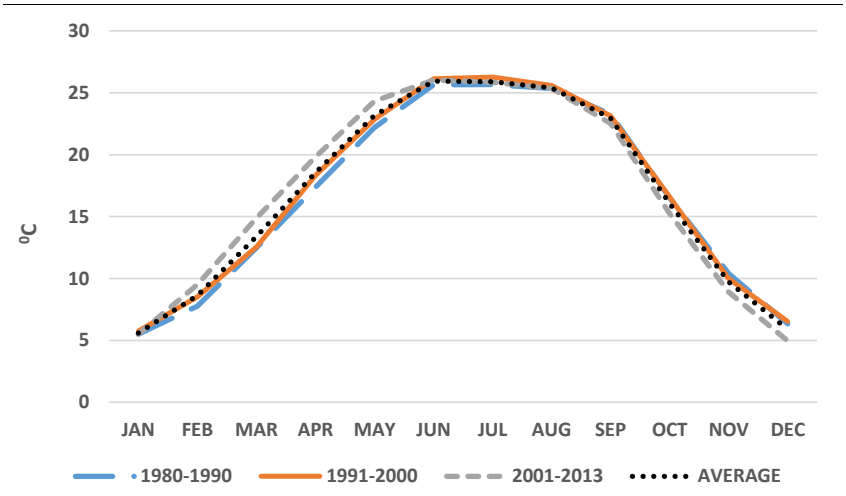


Figure 6.7: Mean Monthly Minimum Temperature at the Jhelum station

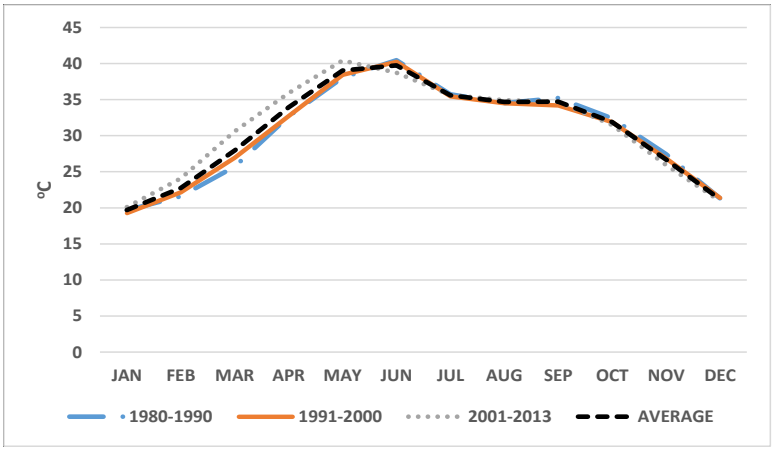


Figure 6.8: Mean Monthly Maximum Temperature for the Jhlelum Station

b) Rainfall

228. The rainfall data has been recorded at various locations in the project area or nearby vicinity by PMD, PID and Surface Water Hydrology (SWH), WAPDA. The description of rainfall stations is given in **Table 6.2**:

Table 6.2: Mean Monthly Rainfall

Sr. No.	Station	Agency	Years of Record	Period of Record
1	Lilla	PID	36	1978-2013
2	Khewra	PID	44	1969-2013
3	Khushab	PID	50	1963-2013
4	Rasul	PID	37	1969-2005, 2011
5	Jhelum	PMD	44	1970-2013
6	Gujjar Khan	SWH	53	1961-2013

229. The PMD is the most concerned department regarding measurement of rainfall and temperature under guidelines of World's Meteorological Organization. It was decided to use the data of Jhelum rain gauge which is operational since 1970. The maximum annual rainfall was recorded as 1300 mm in the year 1997 and minimum annual rainfall was around 500 mm in year 2009 as shown in Figure 6.10.

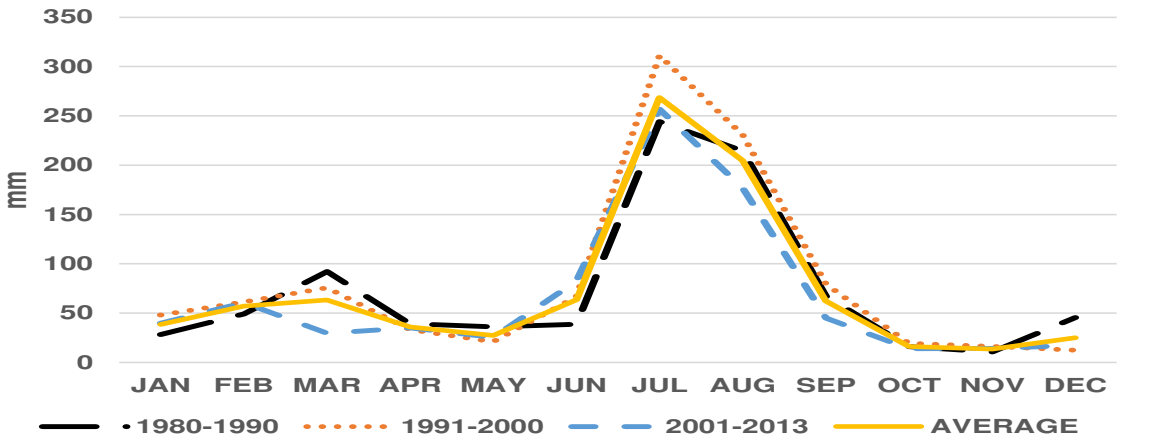


Figure 6.9: Mean Monthly Rainfall at the Jhelum Station

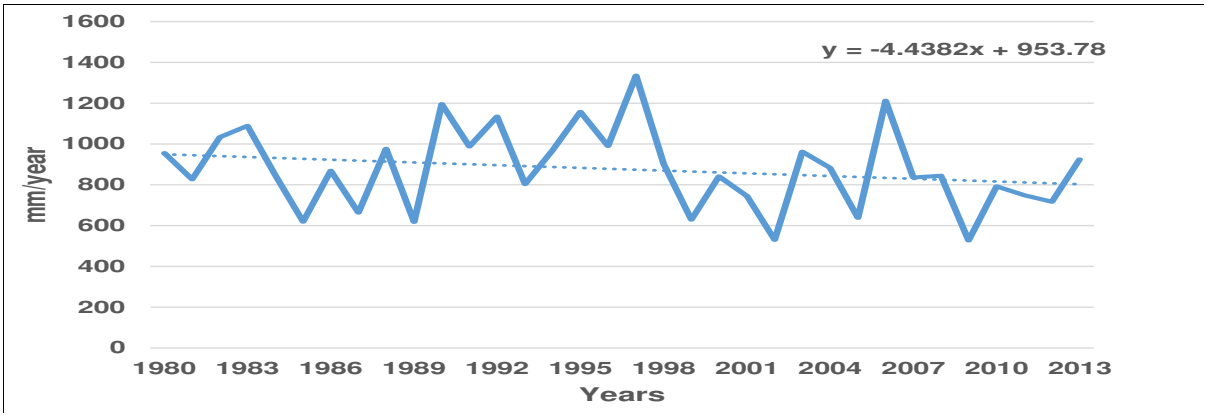


Figure 6.10: Annual Precipitation Records from 1980 to 2013 at the Jhelum Station

6.4.7. Water Resources

230. The major water resources in the project area include the surface as well as groundwater as described in detail below.

a) Surface Water

231. As mentioned above the major surface water source in the project area is Jehlum River along with the large nullahs coming from hill torrents and discharging into Jhelum River. The other surface water sources are the stagnant water ponds in the project's AOI nearby villages and few other ponds of rainwater storage used for livestock consumption. Surface water resources i.e. Jhelum River and nullahs are shown in **Figure 6.11**. Rainwater storage pond in Wara Phapra being utilized for livestock consumptions, is shown as **Figure 6.12**.

Figure 6.11: Jhelum River and Large Rainwater Nullah in the project's AOI

Figure 6.12: Rainwater Storage Pond in Wara Phapra

b) Groundwater

232. The major groundwater sources in the project area and its AOI are tube wells, hand pumps and electric suction pumps for extracting ground water. Water table is high. Hand pumps and electric suction pumps are used for drinking and other household purposes, where ground water is not brackish. Tube wells are being used for agricultural purposes. In addition to that two natural springs i.e. one in Baghanwala and other in Rawal are also being used by local people for drinking, cooking, bathing and other purposes. Ground water sources in the project area and it's AOI are shown in **Figure 6.13**.

Figure 6.13: Ground water Extraction Sources in the project's AOI

6.4.8. Ambient Air and Noise

233. In project AOI, the overall quality of the air is good. Except Jalalpur Sharif and Khewra, all the other settlements are mostly in rural setting. The only source of smoke was household fire places using fire wood in addition to the vehicles producing smoke emissions.

234. The major access road around the project area is Jhelum-Pind Dadan Khan Road being used for light and heavy traffic. The noise pollution is very low in project's AOI mostly except near roads due to vehicular traffic. The major industries are outside project's AOI such as cement factories and ICI Soda Ash Plant. Gharibwal, Dandot and Flying cement factories are in the surroundings of project's AOI. In addition to that some small industries also exist in the project's AOI i.e. lime making kilns, brick kilns and small units for salt crushing. Some close by industries are shown in **Figure 6.14**.

Figure 6.14: Dandot Cement Factory and Lime Kiln near project's AOI

6.4.9. Solid Waste and Wastewater Situation

235. In the project's AOI, no conventional solid waste management system exists. Most of the solid waste was found scattered in the forms of heaps at various locations in villages in project's AOI. Similarly, no proper sewerage system exists in the project's AOI. Open drains carrying sewage are visible in the villages. The sewage through open drains is discharged into the Jhelum River, agriculture fields, flood nallahs and wastewater storage ponds near villages. **Figure 6.15** shows the scattered waste and open drains in the project's AOI.

Figure 6.15: Scattered Solid Waste in Jalalpur Sharif and Open Drain in Malikpur Village

6.4.10. One Time Environmental Monitoring and Testing

236. Consultants have performed the second round of instrumental monitoring in winter season at the detailed design stage to reflect any seasonal fluctuations in air quality, noise levels, water quality and wastewater characteristics (first round of monitoring was conducted during summers during previous EIA studies). Monitoring performed in late summer and testing results are given in **Appendix-III**. The latest monitoring have been carried out at the previous four locations and on some additional points at the different sections of the latest alignment. Appropriate instruments were used and necessary laboratory tests (one time) were performed in order to assess the without project situation of such parameters in the project area.

237. M/s Solution Environmental and Analytical Laboratory (SEAL), an EPA approved lab, was awarded the contract for the environmental monitoring, sampling and testing of ambient air, background noise levels, and water (groundwater and surface water/wastewater) on the basis of competitive bidding. The field work continued for instrumental monitoring from January 20 to 24, 2017 and stopped due to heavy rainfall in the project area. However, the field work was resumed on February 07, 2017 and continued till February 12, 2017 for the instrumental environmental monitoring of the ambient air and background noise levels while samples of the water (groundwater and surface water/ wastewater) were collected and preserved as per standard procedures and transported to the lab for testing. Instrumental environmental monitoring results carried out in winter are attached as **Appendix-IV**. Detail of the monitoring, sampling and testing parameters are given in the **Table 6.3** below:

Table 6.3: Environmental Monitoring, Sampling and Testing Parameters Details

Sr. No	Parameter	No. of Points	Details of Critical Parameters Tested
1	Ambient Air	08	SO_x, SO_2, NO_x, NO_2, CO, SPM, PM_{10}, $PM_{2.5}$, Lead, Ozone, Volatile Organic Compound (VOC), CO_2
2	Noise Levels	08	In dB Scale (A)
3	Ground Water Samples	15	Temperature (During Sample Collection), Color, pH, Turbidity, Total Hardness, Conductivity, Total Dissolved Solids (TDS), Total Suspended Solid (TSS), Bicarbonate, Ammonia (NH_3), Fluoride (F-), Sulfate (SO_{4-2}), Chloride (Cl^-), Nitrate (NO_{3-}), Nitrite, Odor, Taste, Iodine, Sodium (Na), Magnesium (Mg), Calcium as (Ca), Phosphate, Sodium, Potassium, Boron, SAR Iodine (I), Arsenic (As), Total Iron (Fe_{3+}), Zinc (Zn_{2+}), Aluminum, Antimony, Cadmium, Mercury, Nickel, Selenium, Barium, Total Chromium, Copper, Lead, Total Coli forms, Fecal Coli forms (E.Coli).
4	Surface Water/ Wastewater Samples	6	Temperature, pH, Chemical Oxygen Demand (COD), Biological Oxygen Demand (BOD_5), Total Dissolved Solids (TDS), Total Suspended Solids (TSS), Chloride, Fluoride (F-), Oil & grease, Phenols (Total Phenolic Compounds), Cyanide (CN-), Anionic Detergents as MBAS, Sulfate (SO_{4-2}), Sulfide (S), Ammonia NH_3, Aluminum, Antimony, Cadmium (Cd), Chromium (Cr) as Hexavalent & Trivalent, Copper (Cu), Lead (Pb), Nickel (Ni), Zinc (Zn), Iron (Fe), Manganese (Mn), Selenium (Se), Silver (Ag), Arsenic (As), Barium (Ba), Boron (B), Mercury (Hg), Chlorine (Cl), Total Toxic Metals, Turbidity, Dissolved Oxygen, Pesticides, Nutrients as Potassium, Nutrients as Nitrogen, Nutrients as Phosphorous, Total Coliform, Fecal Coliform.

238. The purpose of environmental monitoring was to collect baseline quantitative data of ambient air, background noise levels and water (groundwater and surface water/wastewater) quality in the project's AOI. Instrumental environmental monitoring locations for ambient air, noise levels and water sampling are provided in **Table 6.4** to **6.6** below;

Table 6.4: Ambient Air and Noise Level Monitoring Locations

Sr. No.	Monitoring Locations	Latitude	Longitude
1	Misri More (Construction Camp # 1)	32° 41 '49"	73° 30 '28"
2	Jalalpur Sharif	32° 39' 25"	73° 24' 37"
3	Aadowal	32° 37' 14"	73° 11' 00"
4	Pind Dadan Khan (Construction Camp # 2)	32° 36' 05"	73° 02' 02"
5	Talokar Kurar	32° 28' 22"	72° 29' 52"
6	Rai Shahr	32° 28' 49"	72° 45' 48"
7	Dhudi Thal (Construction Camp # 3)	32° 31' 26"	72° 43' 29"
8	Saroba	32° 34' 28"	72° 51' 53"

Table 6.5: Surface water and Wastewater Sampling Locations

Sr. No.	Sampling Locations	Latitude	Longitude	Sample Type
1	Rai Shahr	32° 28' 36"	72° 46' 00"	Surface Water
2	Head Rasool Barrage	32° 41' 21"	73° 30' 50"	Surface Water
3	Jalalpur Sharif	32° 39' 19"	73° 24' 34"	Surface Water
4	Chakri Karam Khan	32° 40' 52"	73° 21' 06"	Waste Water
5	Pond Near ICI Soda Ash Pond, Khewra	32° 37' 20"	73° 01' 14"	Waste Water
6	Sahowal	32° 40' 15"	73° 09' 22"	Waste Water

Table 6.6: Ground water Sampling Locations

Sr. No.	Category*	Sampling Locations	Latitude	Longitude	Sample Source
1	Category 1	Near Sahotra	32° 34' 02"	73° 00' 38"	Hand Pump
2		Dhok Noora near Bugga Sharif	32° 26' 45"	72° 42' 29"	Hand Pump
3		Dewanpur	32° 37' 21"	73° 16' 17"	Hand Pump
4		Shah Kamir	32° 39' 38"	73° 26' 23"	Hand Pump
5	Category 2	Chak Mujahid	32° 39' 30"	73° 14' 26"	Tube Well
6		Dhok Wenis	32° 36' 40"	72° 59' 07"	Tube Well
7		Talokar Kurar	32° 28' 23"	72° 29' 53"	Tube Well
8		Jalalpur Sharif	32° 39' 18"	73° 24' 45"	Tube Well
9	Category 3	Sahowal	32° 40' 13"	73° 09' 25"	Hand Pump
10		Islam Garh, Khewra	32° 37' 30"	73° 01' 02"	Machine Bore
11		Chakri Karam Khan	32° 40' 51"	73° 21' 07"	Hand Pump
12	Category 4	Misri More, Construction Camp No. 1	32° 41' 49"	73° 30' 28"	Machine Bore
13		P.D. Khan, Construction Camp	32° 36' 08"	73° 02' 04"	Hand Pump

		No. 2			
14	Category 5	Rawal	32° 43' 00"	73° 11' 35"	Natural Stream
15		Baghanwala	32° 42' 29"	73° 13' 56"	Natural Stream

*Categories for ground water sampling are explained in subsequent section.

239. Air quality monitoring on various locations in project area is shown in **Figure 6.16**. Similarly, water quality sampling is also shown in **Figure 6.17** in project area.

Figure 6.16: Ambient Air and Noise Level Monitoring at Feasibility and Detailed Design Stage in project area


Figure 6.17: Water Sampling in project area at Feasibility and Detailed Design Stage in project area

240. The results, analysis and discussions for the ambient air, background noise levels, surface water, groundwater and wastewater are given below:

a. Ambient Air Quality

241. Ambient air quality parameters including Nitrogen Dioxide (NO_2), Nitrogen Oxide (NO), Sulfur Dioxide (SO_2), Carbon Monoxide (CO), Particulate Matter (PM_{10}), and Particulate Matter ($PM_{2.5}$) were continuously monitored for 24 hours at four (04) locations in late summer at project preparatory/feasibility stage. These results were compared with the National Environmental Quality Standards (NEQS) for ambient air (i.e., effective from January, 01, 2013), limiting values of the corresponding parameters. **Table 6.7** below shows the air quality monitoring summarized results at project preparatory/feasibility stage.

242. Similarly, in winter season abovementioned ambient air quality parameters including Suspended Particulate Matter (SPM) and Lead (Pb) were continuously monitored for 24 hours. However, Carbon Dioxide (CO_2), Ozone (O_3) and VOCs were monitored on spot for 1 hours. The monitoring was carried out at eight (08) locations (four locations were same as monitored during feasibility stage) as shown in **Figure 6.18**. These results were compared with the Punjab Environmental Quality Standards (PEQS) for ambient air 2016, limiting values of the corresponding parameters. **Table 6.8** & **6.9** below shows the air quality monitoring summarized results at project detailed design stage.

Table 6.7: Summarized Results of Late Summer Air Quality Monitoring

Parameters	Location				Values			NEQS* (For 24 hours)	WHO/ IFC / USEPA Limits
	Jalalpur Sharif Village	Aduwal Village	Mire Village	Kurar Village	Max	Min	Avg		
	351091.00 E 3614321.0 0 N	329503.00 E 3610698.0 0 N	290091.00 E 3595738.0 0 N	264860.00 E 3595618.0 0 N					
Nitrogen Dioxide (NO_2) ($\mu g/m^3$)	7.68	8.47	7.21	7.64	8.47	7.21	7.75	80 ($\mu g/m^3$)	100 ppb USEPA
Nitrogen Oxide (NO) ($\mu g/m^3$)	2.34	2.16	2.99	2.36	2.99	2.16	2.46	40 ($\mu g/m^3$)	-

Sulfur Dioxide (SO_2) ($\mu g/m^3$)	21.74	10.98	19.72	26.08	26.08	10.98	19.63	120 ($\mu g/m^3$)	125 (mg/m^3)
Carbon Monoxide (CO) (mg/m^3)	2.51	2.58	2.54	2.59	2.59	2.51	2.56	05 (mg/m^3) (For 08 hours)	11 mg/m^3 USEPA
Particulate Matter (PM_{10}) ($\mu g/m^3$)	52.21	58.03	39.50	47.29	58.03	39.05	49.15	150 ($\mu g/m^3$)	150 ($\mu g/m^3$) WHO
Particulate Matter ($PM_{2.5}$) ($\mu g/m^3$)	7.99	8.70	6.18	8.30	8.70	6.18	7.79	35 ($\mu g/m^3$)	35 (µg/m3)

*** NEQS:** National Environmental Quality Standards
Source: Monitored in the project area by Laboratory Team, 28 August - 01 September, 2015.

243. Above results clearly depicts that the ambient air quality monitoring carried out in late summer at the project area in general, is clean as the values of all monitored parameters are far below the EQS limits.

Table 6.8: Summarized Results (Average) of Winter Season Air Quality Monitoring

Parameters	Misri More Construction Camp # 1 32° 41' 49.34" E 73° 30' 27.54"N	Jalalpur Sharif 32.65707N 73.41034E	Aadowal 32° 37' 13.84" N 73° 10' 59.97"E	PD Khan Construction Camp # 2 32.60136N 73.03375E	PEQS* (For 24 hours)	WHO/ IFC or USEPA
CO_2 (ppm)	375	361	325	363	<350 is safe as per global CO_2 limit	
NO ($\mu g/m^3$)	1.9	1.0096	1.2454	2.1	40 ($\mu g/m^3$)	-
NO_2 ($\mu g/m^3$)	2.3599	11.1151	7.3	2.9	80 ($\mu g/m^3$)	100 ppb USEPA
SO_2 ($\mu g/m^3$)	10.7806	10.7278	12.0908	8.8	120 (mg/m^3)	125 (mg/m^3)
PM_{10} ($\mu g/m^3$)	118.33	113.417	108	85.20	150 ($\mu g/m^3$)	150 ($\mu g/m^3$) WHO
$PM_{2.5}$ ($\mu g/m^3$)	13.75	14.9583	16.5417	10.20	35 ($\mu g/m^3$)	35 ($\mu g/m^3$)
SPM ($\mu g/m^3$)	295.833	283.541	270	213	500 ($\mu g/m^3$)	-
Lead (Pb)	0.37	0.1000	0	0.37	-	0.15 $\mu g/m^3$ USEPA
Ozone (O_3) (ppm)	65.3	42.7	32.7	58.1	130 µg/m3	100 $\mu g/m^3$ WHO
VOCs (ppm)	0	0	0	0	-	-
CO (mg/m^3)	0.5807	0.5807	1.1219	0.19	10 mg/m^3	43 mg/m^3 USEPA

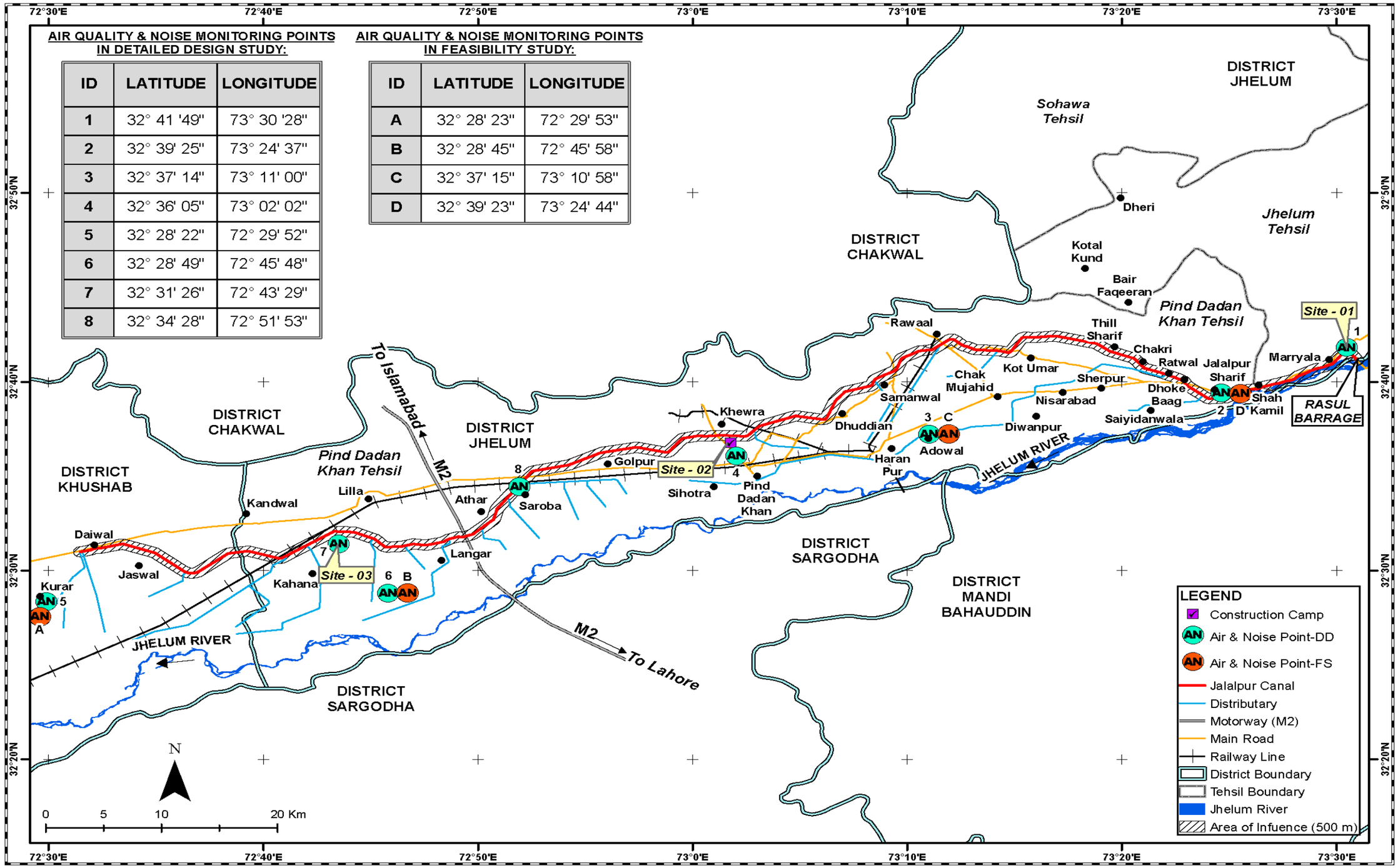


Figure 6.18: Ambient Air and Noise Level Monitoring Points at Feasibility and Detailed Design Stage

Table 6.9: Summarized Results of Winter Season Air Quality Monitoring (2nd Round)

Parameters	Talokar Kurar (Avg. Conc.)	Rai Shahr (Avg. Conc.)	Dhudhi Thal Construction Camp # 3 (Avg. Conc.)	Saroba (Avg. Conc.)	PEQS* (For 24 hours)	WHO/ IFC or USEPA
	32.47272N 72.49818E	32° 28' 49.22" E 72° 45' 48.10"N	32° 28' 49.22" E 72° 45' 48.10"N	32° 31' 26.35" E 72° 43' 29.08"N		
CO_2 (ppm)	321	320	326	338	<350 is safe as per global CO_2 limit	
NO (µg/m³)	1.4914	4.0	2.7	1.5	40 (µg/m³)	-
NO_2 (µg/m³)	8.6360	2.2	3.5	1.91	80 (µg/m³)	100 ppb USEPA
SO_2 (µg/m³)	10.4575	9.9	9.3	9.62	120 (mg/m³)	125 (mg/m³)
PM_{10} (µg/m³)	74.5833	122.91	118.33	113.70	150 (µg/m³)	150 (µg/m³) WHO
$PM_{2.5}$ (µg/m³)	13.8750	22.05	13.75	14.5	35 (µg/m³)	35 (µg/m³)
SPM (µg/m³)	185.6	307.2	294.3	283.8	500 (µg/m³)	-
Lead (Pb)	0	0	0.18	0	-	0.15 µg/m³ USEPA
Ozone (O_3) (ppm)	35.1	32.85	32.85	42.2	130 µg/m3	100 µg/m³ WHO
VOCs (ppm)	0	0	0.3	0	-	-
CO (mg/m³)	1.0286	0.7	1	0.63	10 mg/m³	43 mg/m³ USEPA

244. Similarly, the results presented in Tables 6.8 & 6.9 clearly depicts that the ambient air quality monitoring carried out in winter season at the project area in general, is clean as the values of all monitored parameters are below the values of PEQS.

b. Background Noise Levels

245. The background noise level monitoring at the project preparatory/feasibility stage was carried out at four (04) locations. The results of noise levels were compared with the NEQS for noise 2010 (i.e., effective from July 01, 2012). NEQS has defined four categories of areas for noise level i.e., Residential area (A), Commercial area (B), Industrial area (C) and Silence zone (D), with limiting values of 55 dBA, 65 dBA, 75 dBA and 50A dB, respectively. The overall monitoring points fall into category A (Residential area). Results of background noise levels of late summer monitoring are shown in **Table 6.10** below;

Table 6.10: Summarized Results of Noise Monitoring in Late Summer

Sr. No.	Location	Site Coordinates	Noise Level dB(A)	NEQS (Residential area) dB (A)		Remarks
				Day Time	Night Time	
1	Jalalpur Sharif	351091.00 E 3614321.00 N	60.3-89 dB	55	45	Noise levels were

2	Aduwal	329503.00 E 3610698.00 N	60.1-88.6 dB	55	45	measured on the road side near residential areas.
3	Mire	290091.00 E 3595738.00 N	48-67.2 dB	55	45	
4	Kurar	264860.00 E 3595618.00 N	52.5-72 dB	55	45	

Source: Monitored in the project area by Laboratory Team, 28 August - 01 September, 2015.

246. Similarly, background noise level monitoring at the detailed design stage was carried out at eight (08) locations including four (04) previous locations (Refer to Figure 6.18). The results of Noise levels were compared with the PEQS for noise 2010 (i.e., effective from July 01, 2013). PEQS has defined four categories of areas for noise level i.e., Residential area (A), Commercial area (B), Industrial area (C) and Silence zone (D), with limiting values of 55 dBA, 65 dBA, 75 dBA and 50 dBA, respectively. The overall monitoring points fall into category A (Residential area). Results of background noise levels of late summer monitoring are shown in **Table 6.11** below;

Table 6.11: Summarized Results of Noise Monitoring in winter

Sr. No.	Location	Min (dBA)	Max (dBA)	Avg (dBA)	PEQS Residential (dBA)
1	Misri More (Construction Camp # 1)	57.8	63.7	60.75	55
2	Jalalpur Sharif	53.2	57.6	55.4	
3	Aadowal	48.5	54.9	51.7	
4	PD Khan (Construction Camp # 2)	55.3	59.5	57.4	
5	Talokar Kurar	52.7	57.8	55.3	
6	Rai Shahr	46.8	50.3	48.6	
7	Dhudhi Thal (Construction Camp # 3)	43.6	47.2	45.4	
8	Saroba	52.4	57.8	55.1	

247. This range corresponds to a moderate level noise atmosphere of the rural areas, associated with moderate levels of vehicular traffic and commercial activities.

c. Surface Water Quality

248. Surface water quality of proposed Jalalpur canal would be the same as it will take water from Jhelum River which is excellent in quality. The continuous use of water in the project area will not create any salinity/sodicity problems. However the quantum of this water in the canal would be restricted. All irrigation waters contain dissolved salts but seldom in a sufficiently high concentration to appreciably effect crop growth or the chemical or physical properties of soils. River water of the project contains about 100 to 200 mg/l of soluble salts and is reckoned as excellent in quality[2].

249. During the EIA study at the project preparatory/feasibility stage, the study team has conducted sampling and testing of surface water from six (06) different locations. A summary table depicting testing results of surface water samples collected in late summer and compared with Food and Agriculture Organization (FAO) standards and NEQS is provided in **Table 6.12** below;

[2] Source: NDC Feasibility Report, Jalalpur Irrigation project, 2008

Table 6.12: Surface Water Testing Results in Late Summer

Sr. No.	Parameters	Units	Sampling Locations						FAO Standards
			Kurar	Dhook Sharif	Golpur near Bhelowal	Sauwal	Jalalpur Sharif	Head Rasool	
1	pH	-	7.84	9.4	8.17	7.96	8.18	7.38	6.0-8.5
2	BOD_5	mg/L	5	84	31	16	7	8	---
3	COD	mg/L	29	248	216	134	120	95	---
4	Turbidity	NTU	453	76	102	70.4	19.3	10	---
5	TSS	mg/L	560	50	100	70	150	10	---
6	TDS	mg/L	410	12160	290	1080	230	250	0-2000
7	Aluminium	mg/L	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	---
8	Zinc	mg/L	<1.0	<1.0	<1.0	--	<1.0	<1.0	2.0
9	Antimony	mg/L	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	---
10	Cadmium	mg/L	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	0.01
11	Mercury	mg/L	<0.001	<0.001	<0.001	<.0.001	<0.001	<0.001	<0.005
12	Nickel	mg/L	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	0.2
13	Selenium	mg/L	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	0.02
14	Barium	mg/L	0.148	0.027	0.037	0.239	0.176	0.105	---
15	Boron	mg/L	0.096	0.281	0.28	0.154	0.073	0.012	0-2
16	Manganese	mg/L	<0.5	<0.5	0.5	<0.5	<0.5	<0.5	0.2
17	Chromium	mg/L	0.03	0.04	0.02	0.02	0.02	0.03	0.1
18	Copper	mg/L	0.21	0.14	0.09	0.11	0.06	0.05	0.2
19	Lead	mg/L	0.008	0.003	0.005	0.004	0.006	0.005	0.05
20	Arsenic	mg/L	BDL*	BDL	BDL	BDL	BDL	BDL	0.1
	Biological Parameters								
21	Total Coliforms	MPN** /100mL	$1.6x10^7$	$1.6x10^7$	$1.6x10^7$	$1.6x10^7$	$1.6x10^7$	$1.6x10^7$	---
22	Fecal Coliforms	MPN /100mL	$1.6x10^7$	$9.2x10^6$	$1.6x10^7$	$1.6x10^7$	$1.6x10^7$	$1.6x10^7$	---

*BDL = Below Detection Limit
**MPN = Most Probable Number

250. In context of FAO standards for irrigation, the concentration of TDS in surface water of the Dhook Sharif is above the prescribed limits of FAO (Refer Table 6.12), which may result from the dissolution or weathering of the rocks and soil. Analysis of surface water samples is also performed in the context of NEQS to assess the suitability of water for drinking purpose. Test results reveal that surface water is not fit for human consumption due to presence of microbial contamination, higher values of turbidity, TDS, Cadmium, Mercury, and Boron (Refer Table 6.12). This poor quality of surface water may be due to presence of industrial activities in the area.

251. Similarly, at the detailed design stage in winter surface water monitoring and sampling were tried to carry out from the same above sources such as rainwater nullahs/streams and River. However, due to dry period in the project area except from Jhelum River all the above sources are without water due to which another sample of surface water was taken from Rai Shahr from other locations. The results for Surface Water sampling were compared with the PEQS for Municipal and Liquid Industrial Effluents, limiting values of the corresponding parameters. Locations for surface water sampling are shown in

Figure 6.19. A summary table depicting testing results of surface water samples collected in winter is provided in **Table 6.13** below;

Table 6.13: Surface Water Testing Results in winter

Sr. No.	Parameter	Unit	Head Rasul	Jalalpur Sharif	Rai Shahr	FAO Standards
1	Temperature	^{0}C	18.5	26.5	27.5	-
2	pH	---	8.44	6.96	6.84	6.5-8.4
3	COD	mg/l	30	64	78	-
4	BOD_5	mg/l	18	30	32	-
5	TDS	mg/l	438	1235	2220	2000
6	TSS	mg/l	62	104	124	-
7	Oil & Grease	mg/l	BDL	04	BDL	-
8	Chromium (Hexa & Trivalent)	mg/l	0.28	0.38	0.24	0.1
9	Sulphate (SO_4^{2-})	mg/l	108	254	397	-
10	Iron (Fe)	mg/l	1.14	1.21	1.41	5.0
11	Chlorine (Cl_2) Free	mg/l	0.02	0.07	0.04	-
12	Fluoride (F^-)	mg/l	0.84	2.46	2.62	1.0
13	Chloride	mg/l	174	384	478	355
14	Ammonia (NH_3)	mg/l	7.1	10.4	8.4	-
15	Cadmium (Cd)	mg/l	BDL	0.02	0.02	0.01
16	Lead (Pb)	mg/l	BDL	BDL	BDL	0.05
17	Arsenic (As)	mg/l	0.01	0.02	0.009	0.1
18	Copper (Cu)	mg/l	0.31	1.62	0.34	0.2
19	Barium (Ba)	mg/l	BDL	BDL	BDL	-
20	Selenium (Se)	mg/l	BDL	BDL	0.01	0.02
21	Silver (Ag)	mg/l	BDL	BDL	BDL	-
21	Pesticides	mg/l	0.1	0.14	0.12	-
22	Manganese (Mn)	mg/l	BDL	BDL	BDL	0.2
23	Zinc (Zn)	mg/l	1.72	1.21	2.42	2.0
24	Nickel (Ni)	mg/l	BDL	BDL	BDL	0.2
25	Boron (B)	mg/l	BDL	BDL	BDL	0.7
26	Mercury (Hg)	mg/l	BDL	BDL	BDL	<0.005
27	Total Toxic Metals	mg/l	0.29	0.42	0.27	-
28	Sulphide (S^{2-})	mg/l	BDL	BDL	BDL	-
29	An Ionic Detergent as MBAS	mg/l	BDL	BDL	BDL	-
30	Phenolic Compounds (as phenol)	mg/l	BDL	BDL	BDL	-
31	Cyanide (as CN^-) total	mg/l	0.03	0.02	BDL	-
32	Dissolved Oxygen	mg/l	1.5	4.2	1.6	-
33	Aluminum	mg/l	BDL	BDL	BDL	5.0
34	Antimony	mg/l	BDL	BDL	BDL	-
35	Turbidity	mg/l	0	3	0	-
36	Nutrient as (K)	mg/l	0.05	0.05	0.01	-

37	Nutrient as (N)	mg/l	0.01	0.04	0.008	-
38	Nutrient as (P)	mg/l	0.008	0.02	0.009	-
39	Total Coliform	MPN/100 ml	28	86	48	-
40	Fecal Coliform	MPN/100 ml	12	42	20	-

BDL = Below Detection Limit of Instrument

252. All the above parameters are in the range of PEQS permissible limit values for all the above parameters except copper at Jalalpur Sharif due to mixing of Jalalpur Sharif sewerage into the source.